Digitized by the Internet Archive
in 2010 with funding from
University of Toronto

http://www.archive.org/details/factoryindustria09newy

Factory and Industrial Management

76 I

THE

ENGINEERING MAGAZINE

DEVOTED TO

INDUSTRIAL PROGRESS

VOLUME IX

April to September, 1895

NEW YORK

THE ENGINEERING MAGAZINE CO.

1895

108264
28/2/11

TA
1
F25
V.9

COPYRIGHT, 1895
BY THE ENGINEERING MAGAZINE CO.

INDEX TO VOLUME IX.

APRIL TO SEPTEMBER, 1895.

The titles first appearing under each classification head are those of leading articles in the Magazine. The titles in smaller type, which follow, indicate articles from other journals which have been editorially noticed in the "Review of the Industrial Press." The asterisk (*) marks the occurrence of illustrations.

ARCHITECTURE AND BUILDING.

PAGE.

RECENT ARCHITECTURE IN FRANCE. . . . . *Barr Ferree* 73
With 17 Illustrations.
THE PROPOSAL TO LICENSE ARCHITECTS. . . *John B. Robinson.* 197
HEATING AND VENTILATING TALL BUILDINGS. . *Leicester Allen.* 476
THE ARCHITECTURE OF RAILROAD STATIONS. . *Bradford L. Gilbert.* 649
With 33 Illustrations.
UNINHABITABLE HOUSES IN CITY SLUMS. . . *William Stevenson.* 832
THE ARCHITECTURE OF MODERN HOSPITALS. . *E. C. Gardner.* 1086
With 21 Illustrations.

REVIEWS.

ACOUSTICS of Public Buildings............ 928
Architectural Aberrations.................. 731
Architecture, the Practicable and Impracticable in..............................1113
Artistic Domestic Architecture in America... 931
Bricks and Terra-Cotta.................... 729
Brownstone, A Plea for..................... 930
Bronze Doors.............................1117
Building Stones, Tests of.................. 730
Building Stones, Weathering of... 111
Building, The Tarrant, New York....... ... 505
Chimneys, About.... 107
Competitive Designs a Failure... 501
Drawings and Specifications................ 502
Durant System of Hollow Terra Cotta Construction, The......................1116
Fall of Building at West Broadway and 23d Street, New York..................1118
Hotel, Designing a........................ 323
Insanitary Dwellings...................... 321
Marble, Use and Abuse of.................. 733
Mortar, How to Prepare.................... 324
New City Hall, Jersey City, N. J........ ..1114
Padauk 325
Putty, Removing from Old Sashes.......... 506
Protecting Roofs from Fire................1118
Repair of Ancient Buildings............... 326
Roofs, Slate and Tile..................... 111
Sentiment, The Value of................... 504
Steel Frame Building Construction......... 927
The Practicable and Impracticable in Architecture...............................1113
Waterproofing Brick and Sandstone......... 932
Wind Pressure on Buildings...........108, 734
Wind, Velocity and Pressure of............ 110
INDEX to leading articles in the Architectural and Technical Press......... ....112, 326, 506, 734, 932, 1118

CIVIL ENGINEERING.

[*For additional Civil Engineering, see Railroading and Municipal Engineering.*]

PAGE.

WATER POWERS OF THE WESTERN STATES . . *A. G. Allan.* 17
With 17 Illustrations.
HOW HOLLAND WAS MADE. . . . . . *Foster Crowell.* 204
With 17 Illustrations and Maps.

IRRIGATION SURVEYING IN CALIFORNIA. . . . *Chas. Evan Fowler* 421
With 19 Illustrations.
THE IDEAL CITY ENGINEERING BUREAU. . . . *Francis Collingwood.* 445
THE PROBLEM OF PURE WATER SUPPLIES. . . . *Rudolph Hering.* 450
IMPROVEMENT OF THE DELAWARE RIVER AND THE HARBOR OF PHILADELPHIA. . . . . *John Birkinbine.* 839
With 3 Maps.
SURVEYING AND MAPPING A CITY. . . . . *C. H. Rice.* 1066
ONTARIO DRAIN TUNNEL AND ELECTRIC PLANT. . *C. R. McKay.* 1079
THE MODERN PROBLEM OF GRADE CROSSINGS. . *Wm. O. Webber.* 1034
With 12 Illustrations.

REVIEWS.

ANCHOR-ICE.......................... 115
Blasting (Submarine) at the Iron Gate of the Danube.......................... 937
*Bridge (Lift) at Milwaukee.............. 118
Bridge over the Danube.................. 742
Bridges, Wooden, in Modern Practice......1124
Canal, The Baltic........................ 939
Canadian and Sault Ste. Marie Canals......1125
Cement-Testing........................ 737
Cement, The Abuse of.................. 513
Chloride of Zinc Paint..................1126
*Dam (New) at Holyoke................. 117
Dams, Masonry........................ 331
Deep-Water Route from Lakes to Ocean..... 116
Excavated Material, The Shrinking and Swelling of........................ 508
Highway Commission, Recent Work of the Massachusetts........................ 114
Ice at Intakes, Prevention of.............. 509
Iron and Steel, Effects of Low Temperature on.1121
Iron-Bridge Painting.................. 935
Iron Structures Exposed to Weather, Preservation of........................ 511
Irrigation Canal, The Santa Ana............ 328
Irrigation in Colorado.................. 333
Irrigation in Pecos Valley................ 119
"Jumbo," The......................... 741
Morison's (President) Address............ 935
Originality in Engineering, American...... 513
Portland Cement and Blast Furnace Slag, Adulterated.........................1120
*Re-lining a Weakened Tunnel............1125
River and Harbor Improvement in the United States.......................... 510
Ship-Canal (Manchester) Enterprise, Failure of the.......................... 739
Ship-Canal Route, A New Darien.......... 332
Ship-Canal, The Harlem River............ 940
Ship-Canal, The Manchester.............. 331
Stream Measurements...................1122
Technical Society of the Pacific Coast....... 333
*Tent-Flap and Lock, Improved.......... 740
*Tunnel, Relining a Weakened............1125
Tunnels (Great) of the World............ 329
Wellington (Arthur Mellen), The Late..... 726
Wooden Bridges in Modern Practice.......1124

INDEX to leading articles on Civil Engineering in the Technical Press, including Bridges, Canals, Rivers and Harbors, Hydraulics, Irrigation and Miscellany.....................120, 334, 514, 742, 940, 1126

DOMESTIC ENGINEERING.

PAGE.
THE NEW SCIENCE OF ELECTRIC HEATING. . . *W. S. Hadaway, Jr.* 302
POWER, LIGHT, AND HEAT IN CITY BLOCKS. . *J. E. Talbot* 457
ILLUMINATING GAS FOR HEATING PURPOSES. . *Frederick Siemens.* 860
With 1 Illustration.
HEATING AND VENTILATING TALL BUILDINGS. . *Leicester Allen.* 476

REVIEWS.

BEDDING Plants........................ 122
Churches, Electrical Illumination of........ 127
Church-Heating Plants.................. 337
Country Roads and Roadsides.............1129
Explosion of Domestic Boilers............ 121
*Fallacies in the Trap Vent-Pipe System....1128
Garden-Sculpture Exhibition, A........... 336
Gas-Burner, The Denayrouse Electrical..... 944
Gas, Heating by........................1131
Gas-Stoves, Flueless.................... 516
Greenhouse Heating.................... 336
Heating and Ventilating Engineer, The..... 123
Heating by Gas........................1131
Heating in Engineering Hall, University of Illinois........................ 747
Heating System, An Unusual Combination... 339
Heat Insulation, Tests of.................1130
Holophane Globes...................... 518
Hospital Ventilation................744, 941
Plans for Home Grounds................ 942
Plumbing Work, Double Boiler........... 338
Radiating Surface in Hot-Water Heating.... 124
Radiators, Designing.................... 943
Radiators, The Best Position for.......... 515
Sanitary Fixtures and Fixing............. 335
Sanitation, Home...................... 517

Sanitation, Prehistoric.... 745
Tests of Heat Insulation.... 1130
*Trap Vent-Pipe System, Fallacies in.... 1128
Ventilation in New York.... 743
INDEX to leading articles on Domestic Engineering in the Technical Press, including Heating and Ventilation, Landscape Gardening, Plumbing and Gas-Fitting, and Miscellany.... 125, 339, 519, 747, 944, 1132

ELECTRICITY.

		PAGE.
WATER POWERS OF THE WESTERN STATES. With 17 Illustrations.	*A. G. Allan.*	17
MUNICIPAL OWNERSHIP OF PUBLIC CORPORATIONS.	*M. J. Francisco.*	41
REDUCING THE COST OF ELECTRIC LIGHT.	*Nelson W. Perry.*	57
THE BURNING OF TESLA'S LABORATORY.	*Thomas C. Martin.*	101
THE ILLUMINATION OF STREETS AND PUBLIC PLACES. With 5 Illustrations.	*Franklin L. Pope.*	261
THE NEW SCIENCE OF ELECTRIC HEATING.	*W. S. Hadaway, Jr.*	302
POWER, LIGHT, AND HEAT IN CITY BLOCKS.	*J. E. Talbot.*	457
WILL TRUNK-LINES BE OPERATED BY ELECTRICITY?	*Frank J. Sprague.*	612
THE TROLLEY IN COMPETITION WITH RAILROADS.	*Clarence Deming.*	823
ONTARIO DRAIN TUNNEL AND ELECTRIC PLANT.	*C. R. McKay.*	1079

REVIEWS.

ARC-LIGHTING Up to Date.... 128
Canal Towage by Electricity.... 344
Central Station Coal Consumption.... 343
*Central Station Experiences.... 750
Central Station Practice, Modern.... 748
Cost of Electrical Supplies, The.... 523
Churches, Electrical Illumination of.... 127
Danger from Alternating Currents.... 524
Danger Line in Electric Pressure, The.... 752
Electric Annealing of Armor-Plate.... 130
Electric Bicycle Railway, The Brott.... 173
Electric City, An.... 343
Electric-Conduit Railways.... 522, 950
Electric-Lighting Statistics, Untrustworthy.... 344
Electric Line Construction.... 343
Electric Plant at Baltimore Tunnel.... 1136
Electric Power Transmission, Modern.... 950
Electric Railroads on Highways.... 340
Electric Railway Competition.... 341, 566
Electric Rudder, An.... 144
Electric Wiring, Interior.... 753
Electric Transmission at High Voltage.... 525
Electric vs. Steam Railroads.... 344
Electric vs. Steam Locomotives.... 1134
Electrical Car-Heating.... 569
Electrical Education.... 127
Electrical Engineering at Home and Abroad. 126
Electrical Gas-Burner, The Denayrouse.... 944
Electrical Illumination of Churches.... 127
Electrical Industries of Cleveland.... 129
Electrical Pioneer, Death of an.... 129
Electric Power in Manufactories.... 1133
Electrical Regulation of Steam-Engines.... 150
Electric Street Lighting.... 1138
Electricity as a Profession.... 524
Electricity in a Great Library.... 948
Electricity (Municipal) in Chicago.... 949
Electricity on Elevated Railways.... 751
Electricity on Ordinary Railways.... 130, 945
Electrolysis, A Study of.... 521
Electrolytic Reduction of Aluminum.... 752
Exasperating Electrification.... 525
Generator, A New Thermo-Electric.... 522
High Pressure vs. Low Pressure.... 523
High-Voltage Lamps for Central Stations.... 131
Long-Distance Power Transmission.... 770
Measurement of Artificial Illumination.... 520
Niagara Plans, The.... 946
Niagara Power, Cost of to Consumers.... 520
Polyphase Motor, The.... 521
Power Plant, A Californian.... 342
Ships' Bottoms, Cleaning by Electricity.... 358
St. Louis du Mile End, Lighting of.... 345
Street Lighting, Electric.... 1138
Street Railway Financiering.... 1135
Telegraph in Mexico, The.... 948
Telegraph-Operators, The Selection of.... 949
Telegraphic Line Construction.... 1134
Telephone, Did Reis Invent the.... 946
Telephonic Apparatus, Modern.... 342
*Testing Telegraphic Circuits.... 1136
Transformer, Theory and Practice of the.... 342
Trolley Wires and Lighting.... 1135
Underground Wires in Boston.... 1133
Units of Electrical Measurement.... 525
Water-Power Plant, Successful.... 345
Water-Power Project, An Extensive.... 753
Wires, Underground, in Boston.... 1133
INDEX to leading articles on Electricity in the Technical Press, including Lighting, Power, Telephony and Telegraphy, and Miscellany.... 131, 345, 525, 753, 951, 1138

INDUSTRIAL SOCIOLOGY.

		PAGE.
MUNICIPAL OWNERSHIP OF PUBLIC CORPORATIONS.	*M. J. Francisco.*	41
THE CONTROL OF PUBLIC-SERVICE CORPORATIONS.	*Allen Ripley Foote.*	50

EDUCATIONAL INFLUENCE OF MACHINERY. *Alexander E. Outerbridge, Jr.* 225
MALIGNANT EFFECTS OF THE FREE-SILVER DELUSION. *Edward Atkinson.* 405
HINTS FOR THE MECHANIC AND EMPLOYER. . *Edwin Woodward.* 493
FIRST PRINCIPLES IN RAILROAD MANAGEMENT. . *Benjamin Reece.* 617
THE LEGISLATIVE REGULATION OF RAILROADS. *Albert Fink.* 623
THE SIGNS OF THE TIMES. . . . . *Edward Atkinson.* 811
BUSINESS OPPORTUNITIES IN COLOMBIA. . *C. F. Z. Caracristi.* 883
With 28 Illustrations.
THE BUSINESS SITUATION IN REVIEW. . . *Newton Sharp.* 1005
THE EMANCIPATION OF LABOR BY MACHINERY. *Alexander E. Outerbridge, Jr.* 1012
LABOR LEGISLATION IN THE UNITED STATES. . *Geo. Kirby Holmes.* 1027

REVIEWS.

AGED Poor in England, The.............. 532
Altruria... 136
Arbitration Declined in Leicester.......... 354
Balance of Occupations...................1143
Commercial Union of the States, The....... 756
Commercial Education in Europe..........1147
Compulsory Arbitration.................. 135
Cure for Slums.......................... 757
Department of Labor, The Federal......... 350
Doom of the Small Town, The............ 759
English Engineering Supremacy Departing.. 958
Fallacies that Fool Fiatists................ 529
Farmers, Protection and......... 1145
Financial Arguments, Pictorial............1146
Freeland................................ 134
Gold Hoards 957
Hard Times and the Railroad Employés..... 533
How Free Silver Would Affect the United States 953
Industrial Conditions in Central Europe..... 138
Influence of Workmen-Shareholders in Industrial Control, The................. 528
International Money Clearing-House, Desirability of an..................... 137
Municipal Reform a Failure, Why 761
Occupations, Balance of..................1143
Pictorial Financial Arguments.............1146
Piece-rate System, A.................... 956
Precious Metals (The)—Appreciation and Depreciation 955
Profit-Sharing, Successful................. 139
Protection and Farmers...................1145
"Quintessence of Socialism," The Real.... 349
Relief Department of the Pennsylvania Railroad, The......................... 348
Silver Question, The..................... 531
Twentieth Century, The..................1142
Trade-Unionism, New 353
"Unemployment," The Meaning and Measure of........................ 352
Workmen's Fund........................ 758

INDEX to leading articles on Industrial Sociology in the Technical Press and Current Reviews.
139, 354, 534, 762, 959, 1147

MARINE ENGINEERING.

PAGE.
LESSONS OF THE ELBE DISASTER. . . . *Robert Gillham.* 92
THE GREAT STEAMERS OF LONG ISLAND SOUND. *William A. Fairburn.* 232
With 13 Illustrations.
ROBERT FULTON AND HIS STEAMBOATS. . . *T. C. Purdy.* 868
With 12 Illustrations.
JAMES RUMSEY, STEAMBOAT INVENTOR. . . *James Weir, Jr.* 878
THE EARLIEST TRANSATLANTIC STEAMSHIPS. . *Samuel Ward Stanton.* 1051
With 11 Illustrations

REVIEWS.

A NEW System of Towing................1151
Barge, A Gas-Engine Propelled 144
Bottom Construction of Steel Vessels........ 357
*Broken Rudder (The) of the "St. Louis". 962
Cleansing Ships' Bottoms by Electricity..... 358
Controlling Valves for Steering Engines..... 539
Corrosion of Boilers and Steamships........ 961
Coupling Boilers of Different Systems......1150
"Defender," The.... 765
Electric Rudder, An.................... 144
Engine-Building by the British Government.. 145
Induced Draft vs. Forced Draft for Marine Boilers 536
Japanese Marine, The.................. 960
Laws of Similitude as Affecting Naval Construction, The.......................1149
Lift Locks (Proposed) at Lockport, N. Y... 356
Magnetic Needle, Deflections of the........ 357
Quickest Voyage (The) from China to New York............................ 538
*Recorder, The Thomson & Marsden....... 141
Sailing Vessels, Supersedence of........... 355
Screening of Side Lights, The 76
Shipboard Lodgings for Seamen........... 35

Ships' Bottoms, Cleaning by Electricity..... 358
Similitude, The laws of as Affecting Naval Construction..........................1149
"Somali," the Four-Masted Ship.......... 143
Steam-Pipes.......................... 535
*Steam-Pipe Safety-Valves................ 142
"St. Paul," The Launch of the........ 537
Structural Weakness of Steamers........... 763
Towing, A New System of...............1151
Volume of Ships, The.................. 964
Water-Supply on Board Ships............ 764
Whalebacks......... 358
*Wood and Copper Sheathing for Steel Ships 963
Yacht as a Naval Auxilliary, The..........1148

INDEX to leading articles on Marine Engineering in the Technical Press and Current Reviews 148, 359, 539, 767, 964, 1153

MECHANICAL ENGINEERING.

		PAGE.
ECONOMIC POSSIBILITIES OF THE MILLING MACHINE.	*Horace L. Arnold.*	76
THE EDUCATIONAL INFLUENCE OF MACHINERY.	*Alexander E. Outerbridge, Jr.*	225
A MARVEL OF MECHANICAL ACHIEVEMENT. . . . With 19 Illustrations.	*Robert Perkins.*	281
HINTS FOR THE MECHANIC AND EMPLOYER. .	*Edwin Woodward.*	493
THE MODERN RAILROAD MACHINE-SHOP .. .	*H. D. Gordon.*	705
IS THE INVENTIVE FACULTY A MYTH? . . .	*William H. Smyth.*	851
PRODUCTION UP TO POWER LIMIT. . . .	*Horace L. Arnold.*	916
THE EMANCIPATION OF LABOR BY MACHINERY.	*Alexander E. Outerbridge, Jr.*	1012

REVIEWS.

ALUMINUM Alloys......................... 969
Blacksmith's Shop, Electric Power in.......1137
Boilers and Boiler Settings.................1155
Boilers, How to Inspect................. . 769
Boiler Tests, Reporting... 968
Brass and Bronze in Cincinnati............ 363
Bursting Tests of Lap-Welded Tubes....... 361
*Calorimetric Tests of Steam.............. 965
Centrifugal Pumping from Pits............. 543
*Compressed Air....................... .. 540
Compressed Air in Foundry Work.......... 768
Craft, The Smith's........................1157
*Drawings, Figuring.......................1156
Economy in Steam-Engineering............ 970
Effect of Temperature on Indicator Springs.. 147
Engine, The Field.......................1154
Electric Power in Manufactories...... 1133
Experimental Engine built at Sibley College, Cornell University....... 771
Factor of Stiffness....................... 148
*Figuring Drawings.......................1156
Field Engine, The.......................1154
Fly-Wheel Accidents 149
*Gas-Pipes, Carrying Capacity of........... 967
Hydraulic Air Compression 541
Machine Shop as an Educator for Molders ..1159
Manufactories, Electric Power in..........1133
Power-Transmission, Long Distance........ 770
Raising Water by the Air-Lift............. 542
Rating Feed-Water Heaters.............. 362
Sawing Stone by Wind Power............ 151
Scotch Boiler, The 360
Sewage Water for Steam-Engine Use....... 146
Shafting, Weight of as Related to Economy of Power............................1157
Sickels-Corliss Controversy, The........... 544
Simplon Tunnel Ventilating Fans.......... 151
Smith's Craft, The.......................1157
Soundness of Castings.................. 774
Steam-Engines, Electrical Regulation of.... 150
Steam Freighting with Traction Engines.... 363
Trip Cut-Off, Who Invented the............364
Weight of Shafting as Related to Economy of Power 1157
Wire Ropes, the Care of................. 150
Working Stock in Drop Dies... 772

INDEX to leading articles on Mechanical Engineering in the Technical Press, classified under the Machine Shop, Steam Engineering, and Miscellany. 152, 365, 545, 774, 970, 1159

MINING AND METALLURGY.

		PAGE.
INCREASED GOLD-PRODUCTION IN COLORADO. .	*W. C. Wynkoop.*	97
MINE REPORTS AND MINE-SALTING. . . .	*Walter McDermott.*	311
MALIGNANT EFFECTS OF THE FREE-SILVER DELUSION.	*Edward Atkinson.*	405
WOODEN-STAVE PIPE FOR CONVEYING WATER. . With 9 Illustrations.	*Arthur Lakes.*	462
THE ADVANCES IN MODERN IRON SMELTING. . With Plans.	*John Birkinbine.*	483
THE MAGNETIC SEPARATION OF IRON-ORES. . .	*Clinton M. Ball.*	908
THE REVOLUTION IN STEEL MAKING. . .	*William Metcalf.*	1072
ONTARIO DRAIN TUNNEL AND ELECTRIC PLANT. .	*C. R. McKay.*	1079

REVIEWS.

Acid or Basic Open-Hearth Plates......... 155
Alloys, Definite Combination of 1166
Alloys Research Committee, Third Report of the.... 776
Aluminum, Impurities of Commercial....... 550
Ball Mine, in West Australia.............. 975
Blast-Furnace Cinder, Utilization of... 780
Bonus for Ore Smelting, Canadian 1167
Borax in California and Nevada............ 553
British and American Iron and Steel Trades 158
Bromo-Cyanid Process, A................ 780
Canadian Nickel Mines..................1165
Coal, Alteration of, Due to Subsidence in a French Colliery.................... 778
Coal Mining, Economies in................1163
Coal-Mining Under Sydney Harbor........ 549
Coal-Mining Under the Sea............... 976
Coke Industry, Recent Development of the.. 371
Copper-Mine, A Great................... 371
Crystallization of Steel, The....... 777
Cyanid Process, Progress of the............ 552
Cyanid Treatment of Pyritous Concentrates.. 977
Diamonds.............................. 154
Dredging for Tailings at Dayton........ ... 156
Dry Process of Gold Crushing..............1165
Economies in Coal Mining................1163
Explosives for Use in Coal-Mines.......... 973
Fire, Fighting a Coal Mine 1162
Genesis of Ore-Deposits, The... 368
Gold-Camps, New Mexico's.............. 780
Gold Mining Profits 1166
Gold Crushing, Dry Process of............1164
Gold Nuggets, The Largest............... 781
Gold Slimes, Treatment of............... 157
"Indicator" Feature (The) in Some Gold Occurrences......................... 777
Iron-Ore Supply, The World's............ 976
Iron, Selling Price of in England....... ... 782
Leases, Mining.........................1163
Longwall System, The.................. 977
Manganese in Georgia................... 977
Mica in Georgia........................ 159
Mining Leases..........................1163
Miner's Place (The) in the World........ 158
Mining Subsidences in the Black Country... 978
Monazite, North Carolina................ 370
Nevada, The Mines of.................. 779
Nickel Mines, Canadian..................1165
Ontario's Effort to Make Pig-Iron.......... 159
Opal in New South Wales... 975
Plaster Quarries, Grand Rapids............ 551
Profits of Gold Mining....... 1166
Scotch Pig-Iron, the Manufacture of........ 974
Speculation in Mines..................... 372
Stamp-Milling, The Philosophy of. 548
Steel, Proximate Composition of............ 779
Sulphur in Cast-Iron, Effects of............ 552
Sulphuric-Acid Making from Gold Ores..... 776
Tin-Plate of South Wales................. 781
Transvaal, A Year's Work in the.......... 550
Triumph of Engineering Skill, A.......... 368
Tunnel, A Great Drainage............... 154
Wall Rocks (The) of California Gold Mines. 157
Ward Gold District, Colorado.............1167
Workingmen Mine-Inspectors in France..... 549

Index to leading articles on Mining and Metallurgy in the Technical Press...........159, 373, 553, 782, 978, 1168

MUNICIPAL ENGINEERING.

		PAGE.
Municipal Ownership of Public Corporations.	*M. J. Francisco.*	41
The Control of Public-Service Corporations.	*Allen R. Foote.*	50
Parks, Parkways, and Pleasure Grounds.	*F. Law Olmstead.*	253
The Illumination of Streets by Electricity. With 5 Illustrations.	*Franklin L. Pope.*	261
The Ideal City Engineering Bureau.	*Francis Collingwood.*	445
The Problem of Pure Water-Supplies.	*Rudolph Hering.*	450
Uninhabitable Houses in City Slums.	*William Stevenson.*	832
Surveying and Mapping a City.	*C. H. Rice.*	1066

REVIEWS.

Acetylene, More About................ 378
Bacteria and Other Organisms in Water..... 981
Calcium Carbid, More About......... 557
*Cement Joints for Pipe-Sewers, Tests of.... 164
City Waste, Disposal of.................. 983
Contractors, A Plea for.................. 556
Depth of Sand in Filtration..... 376
European Reservoirs for Water-Supplies..... 379
Filtration, Scientific....................1172
Fire-Protection and Water-Supply.......... 166
Frost, Interference of in Gas-Manufacture... 786
Gas Enrichment.......... 788
Glasgow Hydraulic Power Supply 1173
London, Huge Water Supply for..........1174
Natural Gas a Pioneer for Artificial Gas Fuel 982
Park or Grove.......... 558
Parks, Making and Paying for............ 376
Preservation of Public Pleasure Grounds.... 985
Purifying Sewage and Water by Aeration.... 377
Rapid Transit Problem................... 785
Sanitary Engineering.............. ... 162
Scientific Filtration......................1172
Sewerage in Foreign Cities... 380
Sewer Outlets in Sliding Banks............ 787
Steam Street Railways in Italy............ 560
*Tunneling Through Quicksand........... 163
Water-Gas from Bituminous Coal.......... 165
Water Supply for London, Huge...........1174

Water Supply for Tall Buildings........... 1171
Water-Supply, Notation of Plans for........ 559
Water-Supply, Pollution of 558

INDEX to leading articles on Municipal Engineering in the Technical Press, classified under Gas Supply, Sewage, Streets and Pavements, Water-Supply, and Miscellany.... .... 166, 380, 560, 789, 985, 1174

RAILROADING.

PAGE.
Economy in Railroad Operation. . . . *L. F. Loree.* 7, 271
First Principles in Railroad Management. . *Benjamin Reece.* 617
Famous Scenery on American Railroads. . 585
With 33 Illustrations.
The Legislative Regulation of Railroads. . *Albert Fink.* 623
Reforms in Railroad Management. . . *Henry Clews.* 635
Will Trunk-Lines be Operated by Electricity? *Frank J. Sprague.* 612
The Architecture of Railroad Stations. . *Bradford L. Gilbert.* 649
With 33 Illustrations.
The Advance in Railroad Securities. . . *Thomas L. Greene.* 673
The Car-Building Industry of the United States. *John C. Wait.* 680
A Glimpse of "The Silvery San Juan." . . *T. A. Rickard.* 689
With 10 Illustrations.
The Modern Railroad Machine-Shop. . . *H. D. Gordon.* 705
A Review of Railroad Invention. . . . *C. P. Mackie.* 712
The Causes of Railroad Accidents. . . *Julien A. Hall.* 720
The Trolley in Competition With Railroads. . *Clarence Deming.* 823
The Modern Problem of Grade Crossings. . *Wm. O. Webber.* 1034
With 12 Illustrations.

REVIEWS.

Baltimore Tunnel, Electric Power in..... 1136
Boiler Covering........................ 170
Car-Journals, Weight per Square Inch on... 989
Chilled Car-Wheels..................... 567
Color of Semaphores.................... 1180
Compressed-Air Car-Motors, Hardie's...... 382
Compound Locomotives.................... 1178
Decline in Railway Charges, The.......... 794
Electric Bicycle Railway, The Brott........ 173
Electric-Conduit Railways......... 522
Electric Power in Baltimore Tunnel........ 1136
Electric Railways, Competition of.......... 566
Electric vs. Steam Railroads... 344
Electrical Car-Heating............ 569
Electric Motors for Railways............... 1180
Electricity in the Blacksmith's Shop........ 1137
Electricity on Ordinary Railways........... 130
Forfeiture of Charter..................... 172
Hard Times and the Railroads............. 562
Interlocking, Manual..................... 1179
International Railway Congress............ 387
Interstate Commerce Law, Friction in the Working of the................. 991
Interstate Commerce Statistics............. 789
Locomotives, First Inside.................. 1182
Locomotives, Balanced.................... 169
Locomotives, Compound.................... 1178
Locomotives, Counter-Balancing........... 987
Locomotives, Efficiency of Compound...... 795
Locomotives, Heavy, Track for............ 1177
Locomotives, Electric vs. Steam........... 1134
*Locomotives, Oil Fuel for................ 171
Locomotives with More than Two Cranks... 565
Manual, Interlocking.................... 1179
Motors for Railways, Electric............. 1180
Pooling Arrangement, Effects of Upon Commerce 795
Race, Railway in Great Britain............ 1181
Railroad Construction, Western............ 391
Railroad Discipline...... 383
Railroads in Default...................... 563
Semaphores, Color of..... 1180
Single-Drive Wheels, The Return to........ 568
Steel-Tired Wheels, Inspection of... 988
Street Railway Financiering............... 1135
Street Railway Motormen and Repairs...... 385
Street Railway Wheel-Treads and Flanges.. 384
Street Railway Statistics..... 991
Street Railways (Steam) in Italy.......... 560
Timber-Preserving Methods and Appliances.. 168
*Track Construction Without Ties.. 1181
Track for Heavy Locomotives............. 1177
Transition Curves, The Practical Use of..... 793
Train-Robbing.......................... 386
Tubular-Frame Car, A New.............. 173
Wheel-Treads and Flanges, Street Railway.. 384

INDEX to leading articles on Railroading and Street Railways in the Technical Press.
173, 387, 569, 798, [illegible] 1183

MISCELLANEOUS.

PAGE.
THE COMMERCIAL VALUE OF WEATHER FORECASTS. *E. B. Dunn.* 1
MEANING OF THE RECENT UNITED STATES PATENT DECISION. *Park Benjamin.* 189
THE GROWTH OF AMERICAN EXPORT TRADE. *Thomas A. Eddy.* 413
Carl Schurz. 418
A GLIMPSE OF "THE SILVERY SAN JUAN." *T. A. Rickard.* 689
With 10 Illustrations.
NATURAL SCIENCE TRAINING FOR ENGINEERS. *Prof. N. S. Shaler.* 1021

REVIEWS.

ALABASTER, The Volterra 804
Anchor Ice 397, 1002
Anthony's (Prof.) Reply to Mr. Woodward 184
Argon, The New Element 177
Ballance, A Novel Chemical 1189
Balloon, To the North Pole in 1187
Bicycle (The) in Health and Disease 393
Cable Post, A 802
Carbon Dioxid as a Refrigerant 574
Charcoal, Manufacture and Uses of Pulverized 573
Charlottenburg Mechanical Testing Stations, The 1188
Chemical Balance, A Novel 1189
Clays, Fire-Brick 392
Correction, A Definite 185
Cotton-Seed Oil, The Production and Uses of 1000
Education (University) for Engineers 176
Flying-Machine, Wellner's Sail-Wheel 180
Forest Removal, Effect of upon Climate 181
*Friction of Belting and Shafting 183
Gives it a Name 397, 1003
Hydraulic Engineering 399, 1002
Illiteracy, Scientific 391
Innovation in Printing, An 1186
Kauri Gum Industry in New Zealand, The 1190
Libraries of the United States, The Great 801
Liquid Air, The Scientific Uses of 804
Low Prices for Iron Ores 1003
Mars a Disappointment 577
Mechanical Testing Stations, The Charlottenburg 1188
North Pole, To the, in a Balloon 1187
Parks, Parkways, Etc. 1002
Pitch Lake of Trinidad, The 995
Preserving Wood and the Haskinizing Process 806
Printing, An Innovation in 1186
Rainfall, Central American 572
Rain-Making 179
Rayleigh (Lord) Honored 395
Science, An Elementary Lesson in 1137
Science vs. Nature 184
Sound, A Standard of 998
Spectrum Top, The Artificial 576
Tanning School, The Saxony 395
Technical Research 996
Textile Schools in Massachusetts 394
To the North Pole in a Balloon 1187
Wood Stave Pipe 1003
INDEX to leading articles from the Technical Press classified as Scientific Miscellany. 181, 395, 577, 807, 1000, 1191

BOOKS REVIEWED.

American Society of Mechanical Engineers—Transactions for 1894 400
Anthony, Gardner C.—Elements of Mechanical Drawing 580
Baldwin, James Work—Mental Development in the Child and the Race 186
Bolton, Reginald—Motive Powers and their Practical Selection 1193
Briggs, William—An Elementary Text-Book of Hydrostatics 1193
Brooks, William—A Text-Book of Dynamics 401
Brooks, William—A Text-Book of Statics 400
Du Bois, A. J.—The Elementary Principles of Mechanics 401
Funk & Wagnalls—The Standard Dictionary of the English Language 579
Hollins, H. B. & Co.—A Supplement to the Street Railway Journal 1194
Humphreys, David C.—Notes on Rankine's Civil Engineering 186
Huxley, Thomas H.—Evolution and Ethics, and Other Essays 401
Kneass, Strickland L.—Practice and Theory of The Injector 1194
Martin, Thomas Commerford—Electrical Boats and Navigation 186
Meads, S. P.—Elements of Physics for Use in Secondary Schools 401
Reagan, H, C., Jr.—Electrical Engineers' and Students' Chart and Hand-Book of the Brush Arc Light System 1194
Schimf, Henry W.—A Text-Book of Volumetric Analysis 187
Slingo, W., and Brooker, A.—Electrical Engineering for Electric Light Artisans and Students 187
Stewart, R. Wallace—A Text-Book of Magnetism and Electricity 1193
Ternant, A. L.—The Telegraph 400
Yeo, John—Steam and the Marine Steam Engine 187
"The Electrician's" Electrical Trades Directory for 1895 400

ENGINEERING SOCIETY
SCHOOL OF PRACTICAL SCIENCE,
TORONTO.

THE
ENGINEERING MAGAZINE

VOL. IX. APRIL, 1895. NO. 1.

THE COMMERCIAL VALUE OF WEATHER FORECASTS.

By E. B. Dunn.

THE severe storms and cold waves that have lately traversed our country, causing the loss of many lives, doing great damage to property, impeding railway and ocean traffic, and in fact bringing business to a standstill in many sections, affords an excellent opportunity to show the relationship between the United States Weather Bureau and the commercial interests of our country. The value of weather forecasts and special bulletins giving warning of the approach of hurricanes, cyclones, heavy snow storms, sleet, cold waves, frost, and warm waves is incalculable, and business men have not been slow in realizing the fact that to be forewarned is to be forearmed.

It was but a few years ago that the forecasts of the weather—or "probabilities," as they were then called—were scoffed at and made the occasion of much criticism. To-day they hold first place in point of importance in the daily press; they are read far and wide, and every man, woman, and child makes calculations accordingly.

There is no known science which has made such strides during the first twenty-five years of its existence as the science of the weather. When it is considered that less than twenty-five years ago the first attempt at forecasting the weather was made in this country, is it not wonderful,—the accuracy which has been attained, the verifications having reached almost ninety per cent.?

When forecasts were first made, they were general and for large sections of the country; for instance, the entire Atlantic coast was divided into three sections, the "New England, Middle, and South Atlantic States." To-day the forecasts are made for States and parts

Copyright, 1895, by the Engineering Magazine Company.

of States, and, in the commercial and business centres, for cities, which require closer attention to the exigencies of the occasion.

The lives, property, and money saved by the timely warning to our merchants of one severe storm or cold wave more than compensates the government for the maintenance of this important bureau. As soon as the approach of a storm is observed, or the development of one at any point with sufficient force to warrant apprehension of danger, warnings of its position, probable course, force, severity, and duration are telegraphed from the main office at Washington and the stations throughout the country in the path of the storm to all places and persons within the line of danger. The information is given to the press, bulletined in all post-offices, railway stations, exchanges, and many public and conspicuous places,—in fact, the warnings are disseminated in the best possible manner. For the benefit of mariners signals of warning—flags during the day and lanterns at night—are displayed along the Atlantic coast and on the great lakes. Mariners on the lakes, if not in a position to obtain information relative to storms, may apply by telegraph at government expense,—if on Lakes Erie or Ontario, to Observer at Buffalo; if on Lakes Michigan, Huron, or Superior, to Observer at Chicago. Weather maps showing the daily atmospheric conditions, with storms and cold and warm waves outlined, are issued from all the larger stations throughout the country. Their appreciation may best be understood from the remarks of a captain of a Pacific mail steamship, who said: "I would as soon leave port without my clothing as without my weather map."

On the approach of the great West Indian cyclone, which swept northward along the Atlantic coast on February 12 and 13, 1894, special warnings were scattered far and wide; the press associations and daily newspapers heralded the news so thoroughly that for 24 hours in advance the shipping interests along the coast from Florida to Maine were actively seeking a harbor of refuge, and for the first time on record not a vessel, not even the ocean liners, left port, so thoroughly was confidence placed in the warnings.

In commenting on this unprecedented fact, the maritime journals of the country said that the heeding of the warnings had undoubtedly been the means of saving millions of dollars and many lives.

The Honorable J. Sterling Morton, secretary of agriculture, in his annual report to Congress for 1894, states that "during the year much inquiry was elicited as to the probable value of the forecast work of the Weather Bureau. It is difficult to estimate with any degree of precision or accuracy the real value of the current work of the Weather Bureau. It, however, affects almost innumerable interests. It varies from day to day in its influence upon, protection over, and conservation of, those multifarious interests. Directors of the State weather service in Ohio and North Carolina report—the first, a saving of $200,000 by the warning of January 24, 1894 ; the latter estimated that during the season $200,000 worth of farm products in his immediate territory was saved from frost by the same means. These estimates are conservative. They only hint at the vast possible value of these warnings.

"In January, 1894, the steamship 'Rappahannock' was stranded, and the nearest Weather Bureau observer, at Cape Henry, Va., immediately telegraphed a wrecking company at Norfolk to the effect that, unless the stranded steamer was lightened up enough to float at high tide on the night of the 24th, she would be broken to pieces on the rocks by a coming storm. The observer's message was communicated to the 'Rappahannock' by flag signals. This warning caused the wrecking company to exert themselves to the utmost, and they consequently discharged a sufficient cargo to enable the vessel to float that night at 10.35, and at 12.45 a. m. on the next day the vessel was floated out of danger, because of the Weather Bureau warnings. An intensely severe westerly and northerly gale (which had been forecasted) with freezing temperature, rain, and a heavy sea, set in, and it is generally conceded that, had the vessel continued aground until the storm struck her, she would have been pounded to pieces, and, with her cargo valued at $600,000, proved a total loss.

"The September tropical storm of 1894 was forecasted with great accuracy and exactness. Warnings were sent very generally along the Atlantic coast. Because of the admonitions of the Weather Bureau relative to that particular storm 1089 vessels, valued at $17,100,413, were retained in port.

"During the tropical storm of October, 1894, 1216 vessels, valued at $19,183,500, were prevented from going out to sea because of the warnings issued by the United States Weather Bureau. The value of the cargoes in all this multitude of ships which were prevented from encountering the tropical storms of September and October has not been estimated. It is, however, reasonable to presume that the cargoes were worth much more than the ships, and therefore safe to assume that the Weather Bureau warnings for the two months, which kept in port vessels valued in the aggregate at $36,283,913, also preserved from the perils of those most disastrous and far-sweeping storms several million dollars worth of merchandise, commodities, and other property in transit.

"Besides that vast amount of value in materials, many human lives undoubtedly were preserved from jeopardy and death.

"It is not practicable to estimate the value of the warnings to agriculture and inland commerce up to this time."

During the storm of September 27–30, 1894, there were held at anchor in the harbor of New York not less than two hundred and fifty vessels of all classes, from fishing smacks to the large ocean liners. But two made any attempt to leave port after the warning of the coming storm was given. When they reached Sandy Hook, one found she could not withstand the gale and returned to Sandy Hook bay; the other, unfortunately, was in charge of a foolhardy commander, willing to risk the lives of all on board and take all chances on the foundering of his vessel. He proceeded on his course only to suffer great damage. The decks of the vessel were swept, the mainmast was carried away, the second mate and one seaman washed overboard and lost, and the vessel arrived at its destination five days over-due, in a most crippled condition, while the vessels remaining in port in safety until after the storm put out to sea two days late, but had the assurance of a safe and comfortable passage. The filing of vessels out of port after the storm was an unusual and beautiful sight, which was commented upon in the daily press.

The secretary of agriculture, in another paragraph, states that "public appreciation of the warnings of the Weather Bureau and the growing importance attached to their value are very well illustrated in a recent suit against the Pennsylvania Railroad Company for the value of a canal boat wrecked during the storm of August 24-25, 1894. The lost boat broke loose from a Pennsylvania Railroad Company tug, by which it was being towed to South Amboy, N. J. In the progress of the trial Sergeant Dunn, (the writer) the Weather Bureau observer at New York city, testified that he had warned the public, including the railroad officials, of the approaching storm from Cape Hatteras. The question raised in the case is whether it is a legal duty of those having water-craft in their charge to respect Weather Bureau warnings. The decision of the court is awaited with intense curiosity, because it involves, to a certain extent, the value of Weather Bureau warnings. It all indicates that in the near future marine insurance may contain in every policy a proviso by which the insurance will become inoperative and void in case of loss by a storm against which the Weather Bureau shall have sent out timely warnings."

The railroad companies of the country are kept fully informed of the approach of heavy snow storms, sleet, and cold and warm waves. These conditions especially apply in their cases. If warning of heavy snow is given four or six hours in advance, they are enabled to get out and hold in readiness their snow-ploughs and crews; heavy trains are divided,—especially soft-coal trains, the coal absorbing an unusual amount of moisture and increasing the weight; shoots and switches are looked after to prevent them from freezing and being blocked with snow; perishable freight is run under cover or hastened to its destination or held over; in fact, the advantages which the railroads enjoy by advance warnings are too numerous to recite.

Year by year, through the agency of the press and the various magazines, the general public have become enlightened as to the value of the Weather Bureau work. The daily observations showing weather conditions at all hours of the day or night form the basis of important evidence in many cases tried before the higher courts of the country. The supreme court of the United States decided in a case on appeal that the records of the Weather Bureau are competent evidence when produced in court or testified to by the observer in charge of records.

To further enhance the value of general warnings, one of the largest railroads of this country has in contemplation a system whereby it intends to coöperate with the United States Weather Bureau by having daily observations taken all along the line of its road. The utility of such a course has been pointed out by myself. In such a case the expense would be merely nominal in comparison to the advantages to be derived; for then the general atmospheric conditions, supplemented by the local observations, would enable the road to determine the advance of all atmospheric changes and keep track of the movement and passage of storms hour by hour; there would be fewer accidents through carelessness of engineers, for the accurate reports of wind velocity and pressure along the road would deprive such engineers of some of the false excuses which they now put forward. It could be readily determined whether or not a train destined for a certain point with perishable freight could accomplish the journey before being overtaken by the cold or storm, and whether it would be safe to start trains out on the approach of a storm. The road's entire system would be under complete control, and its managers would know just what to do and when to act in order to successfully combat the elements.

I expect to see, before many years, every railroad in this country taking systematic observations and coöperating with the United States Weather Bureau in this valuable work; it needs but a test to make it a permanent feature of railroading.

The warnings of freshets or floods along our great interior waterways are deserving of more than passing notice. These warnings have been the means of saving much property and many lives. The transportation companies along the line of the Mississippi are especially interested during the spring of the year, and eagerly seek the reports showing the height of the rivers and the prospective rise or fall.

The entire agricultural industries of the country receive as much benefit from the forecasts and warnings as the maritime interests. Extra precaution is taken to furnish full detail of coming changes during planting and harvesting. The fruit and tobacco-growers receive the warnings of frost and cold waves; they do the most of their picking, packing, and shipping by and with the advice furnished by the Weather Bureau. Hardly a vessel containing a cargo of fruit or perishable goods enters the port of New York that the weather officer is not consulted before the hatches are opened and it is found whether or not the cargo can be discharged without risk of freezing. The business of the Cotton, Produce, and Mercantile Exchanges is governed almost entirely by weather changes. A rise or fall in the market may be the result of a cold wave, storm, or drought in the agricultural districts; consequently forecasts must be consulted to regulate buying or selling.

You may now ask the cause of the rapidly-increasing improvement in the weather-forecast work that has brought it to such a high standard of excellence. Such a question is easily answered by one who has spent the greater portion of his life in such work, and I can with great pride say that it is due to the untiring efforts of the Honorable J. Sterling Morton, secretary of agriculture, the only secretary ever in control of the Weather Bureau who gave this most valuable branch of government his personal attention. He has taken such an interest in the work as to inspire each man to renewed efforts. He has made a standard of excellence which none but those possessing the requisite qualifications can hope to attain. His promotions are made on the ground of merit. He conducts the affairs of the service on business principles; throws aside theory and places faith in practical work and common-sense methods. Such a system is developing its own reward.

The appropriation for the Weather Bureau for 1894 was $951,100; of this amount, $138,500 was turned back into the treasury, leaving the total expense at $812,711. This was accomplished by Secretary Morton, who gives more efficient service and improved forecasts with greatly reduced expense to the tax-payers.

From the establishment of the Weather Bureau up to July 1, 1891, it was under the control of the war department, and was conducted under military rule and form; its organization, however, was on a scientific basis and free from the contamination of politics. On the above date that part of the Bureau which dealt with the science of the weather was transferred by act of congress to the agricultural department, where it has since remained. At the time of transfer considerable fear was expressed lest politics should enter into the weather work and destroy its purely scientific character, thereby destroying public confidence in it. Seeing the threatened danger to this important branch of public service, Secretary Morton immediately took steps to have the entire service placed within the bounds of civil service, so that its usefulness might not be impaired, but increased.

ECONOMY IN RAILWAY OPERATION.

(FIRST PAPER.)

By L. F. Loree.

IT has been the fashion to designate epochs in the history of the human race by certain distinguishing characteristics, and so not infrequently we hear our own times spoken of as the age of steam. To be more specific, we might fitly call the century now closing the age of transportation. It was within this century that man's means of transportation first enabled him to exceed the speed of a fast horse, and the ability to so move himself and his belongings is working great changes in him and in his relations with his fellows. The strides with which the carrying-trade of the world has developed within the last generation are indicated by Munhall, who places the total railway mileage of the world at about 400,000, and estimates the total weight carried in 1892 at 1,746,000,000 tons. Along with this enormous growth in mileage and business handled has gone a reduction in charges that is equally remarkable, the average freight-rate for the world having fallen from 16 cents per ton-mile in 1850 to 2 cents in 1892. It is the purpose of this paper, and of one to follow it, to show in what ways this economy in railway operation has been effected and may be continued.

The most marked change in the direction of reducing general expenses has been in the consolidation of minor lines into great systems. This has been brought about by purchase and by lease, and has been pushed still further in certain directions by traffic agreements and traffic associations. Van Oss says that "in 1889 approximately 2450 minor lines had been merged into the thirty-three vast corporations to which nearly one-half of the American railways belong." The entire 167,000 miles were owned by 1705 companies, but the operations of these were controlled by 436 organizations. This has made possible a remarkable reduction in highly-paid officials, until, as has been shown by the *Railway Age*, 15 western companies, operating one-fourth of the mileage of the country and employing 170,657 men with a total payroll of $107,888,697, disburse in salaries of $5000 and over per annum $1,205,151, or $1\frac{1}{10}$ per cent.,—a proportion which is insignificant. It has also made possible the employment of the most highly-skilled experts, and the purchase of supplies in large quantities and on the most favorable terms,—the composition and quality of the supplies being secured by specifications and analysis through bureaus of inspection and tests, and in many cases the manufacturer's profits being saved through the maintenance by the companies of their own shops. The enlargement of control to cover large territories or diversified traffic permits of special economy in the use of the force and equipment. For example, during the summer and the season of navigation many of the engines and crews of the Chicago and Northwestern Railway are engaged in the transportation of iron ore from mines to the loading docks. The navigation season closes about the time the eastward movement of grain sets in, when this force is transferred to the company's lines further south. Thus much waste of energy is prevented and better service maintained. This tendency to consolidation still continues, and we may look to see much more accomplished. It is only within the last 3 years that the cars of the Pennsylvania Railroad have been pooled, and even yet the earnings and expenses have to be adjusted by book account. It is probable that the results of consolidation have not been more than half realized.

About the headquarters of the great companies gather many of the abuses incident to the existence of power: precedent and observance of form, sacrificing virility to system; a curious sort of contentment, and impatience of suggestions that seem to involve new methods or increased duties; nepotism (though to a less degree than would appear probable); and intrigue. Listen to Sir George Findlay's description of how things are done on the London and North Western Railway. "We will suppose, for example, that a goods agent conceives it to be necessary for an additional siding to be laid down at a station. He makes a report to that effect to the manager of the district; the latter inquires into the facts on the spot, and, if he concurs in the necessity, reports his recommendations to the general manager. The latter consults in the first instance the chief goods manager, or the superintendent of the line (general superintendent), as the case may be, and, if his report be favorable, authorizes the engineer to prepare a plan and estimate. The plan, when ready, is subjected to the criticism of the district officer, the chief officer, and the general manager, and, if all are satisfied, the directors are next asked to authorize the necessary outlay. But even this is not all, for finally the plan has to be signed by the chairman of the company before the engineer commences operations, and that gentleman, who keeps a watchful guard over the company's purse-strings, has to be convinced that the expenditure is not only desirable, but actually unavoidable, before his signature can be obtained. Thus the shareholders may rest perfectly easy in the assurance that their money is not dissipated in needless accommodation works." And all this without any recognition of the humor of the thing. Of course, it is conceivable that the mountain, after much labor, may bring forth a mouse, but it hardly seems possible that the poor goods agent would ever venture on a second recommendation. The plan is not, however, without venerable precedent. It is said of the ancient Persian king that "the whole empire belonged to him, and all its inhabitants were his slaves. If he happened to be struck to the heart by a look cast from under a pair of black-edged eyelids, he had only to say the word ; she was at once taken to the apartment of the women, and her parents received the congratulations of their friends. But then he was not allowed to see his beloved for a twelvemonth : six months she must be prepared with the oil of myrrh, six months with the sweet odors, before she was sufficiently purified and perfumed to receive the august embraces of the king, and to soothe a passion which meanwhile had ample time to cool." So we may well consider whether, however admirable the system may be for repressing the troublesome activities of subordinates, it may not prove equally effective in driving off valuable patrons, and preventing improvements in plant and practice.

The tendency is for general expenses to increase with disproportionate rapidity, and it has seemed impossible to effect any reduction in them. Not long since, in investigating the expenses of a road, I found that, under the stress of the 1893 panic, the expenses under other heads had been reduced $23\frac{1}{10}$ per cent., while the general expenses, after eliminating the item of taxes, showed an *increase* of $7\frac{1}{10}$ per cent. Is it possible that the courage that is remorseless in cutting down the forces when unacquainted with the persons affected falters when face to face with the responsibility? Or do departments claiming equal power hold each other in equilibrium, and prevent action? It is probable that here is to be found one of the most productive fields for the economy of the future.

MAINTENANCE OF WAY AND STRUCTURES.

No department has shown a more remarkable economy in recent years than has maintenance of way, whether tested by the expense per train-mile or by the expense per mile of railway. This improvement is largely due to the substitution of the steel rail for the iron rail formerly used, to the better drainage of the road-bed, and to the substitution of first-class ballast. Lardner says that, when the 35-lb. iron rails were laid down on the Louisville & Memphis, they were considered strong to superfluity, and were expected to last from 100 to 150 years; by 1873, through the deterioration in the quality of the rail and the heavy increase in the tonnage, they were wearing out on the Pennsylvania lines in from six months to two years. We are now gradually repeating with the steel rail our experience with the iron rail. Not only is it impossible to secure in the modern fast-going mills that physical hardness formerly produced by cold finishing, but, as Mr. O. Chanute long ago pointed out, the pressure of the locomotive drivers approximates the ultimate crushing resistance of the metal. To the locomotive is due nearly all the destruction, and the rails are wearing out in from two to twelve years. It is possible that for a time we shall seek economy in a lower price, and there is considerable room for improvement in this direction. Steel rails are now quoted at $22 per ton: steel billets that require very little less work are selling at $17. It is possible, on this basis, for rails to sell at $18. But we must eventually seek to increase the rail in height and weight and to improve the material,—either by making the steel lower in carbon and tempering the rails in oil while at a dead red heat, by a proper arrangement of the cooling table, or by the substitution of nickel steel. Rails of this last material can be furnished at $70 per ton, or about what we were paying for iron when we abandoned its use.

PRACTICAL SCIENCE
TORONTO

MAINTENANCE OF EQUIPMENT.

The following table illustrates the economy effected in the United States in the matter of motive power:

1883–1885.	No. Locomotives.	No. per mile.	Average miles per Locomotive per month.
Continent	32,591	0.39	15,096
United Kingdom	14,200	0.76	18,362
United States	23,823	0.25	23,928
P. R. R.—1894	......	......	28,859

Mr. Evans claimed that "clearly the American locomotive with bogie truck and solid bar frame was the prime factor in economy" of American practice. Great improvements have been made in the construction of the machine. In 1840 the cost of working the locomotive per train mile in England was 37.32 cents; in 1845 this had fallen to 21.4 cents,—the decrease being due to the fact that "shortly after 1840 an essential improvement took place in the construction of engines by the introduction of the system of working steam expansively." The perfecting of the design and fit of the working parts has gone along with the simplification of the machine and the increase in its size and weight, until we now have an engine that is compact, durable, and well adapted to the work it must do. A further large reduction in the working expenses is due to the "first in, first out" system of running introduced on the Pennsylvania Railroad in 1878, by which fewer engines are used, greatly increased mileage is obtained from those in service, and the frequency of alternate heating and cooling incident to the "one man one engine" practice is much lessened.

There still remains a large mileage in this country where this system should be introduced: and where this is not practicable, the system of "link working" will still show an improvement. It is to be observed that the expense on account of fuel and stores exceeds the wages of the engine crew, and too much care cannot be taken to educate the crew in the economical use of these supplies. On many roads a "premium system" is in effect, by which the company divides with the men the savings above a specified maximum amount allowed for the run. This system, if properly followed up, is very productive of good results. The engine crews are, as a rule, a very superior class of men, with a good deal of pride in their business, and it is not a difficult thing to interest them in improved methods, if the matter is properly and clearly set before them. During the six summer months of 1894 we reduced the coal consumed per train mile 18 per cent. against the corresponding period of 1893, and the stores per 100 miles run by one-half. Within the last few years there has been a considerable construction of engines of the "compound" type, which makes it impossible for a careless engineer to run the engine as wastefully as he could run a simple engine. The advantage of the compound over the simple engine, in coal consumption when both are run to the best advantage, is perhaps 15 per cent. Much economy may also be effected in selecting the engine fuel, not only with regard to its steaming qualities, but with regard to its ability to stand handling and weathering. In few cases is the question of *quality*, as opposed to mere quantity, of greater importance. The item of water in the limestone regions is of great importance, not only because of the actual cost of furnishing it, but because of its destructive effects on the engine. At division points, or where large quantities are used, the filtering process, as practised on the London & North Western, or the precipitation by chemical action, as on the Midland at Derby, might be expected to show good results. Often a particularly bad lot of water may be avoided by changes permitting the removal of the tank to a different location. Few things will better repay study than a comparison of the analyses of the waters used on engines.

In the matter of stock carried the same reductions are possible as in the car department. By the use of up-to-date tools, and the convenient arrangement of the work and materials, considerable reductions can be made in the cost of repairs. By such means the cost of repairs on 170 engines averaging $926.61 each, at one shop during the past year, was reduced 10 1-2 per cent.

Secrist's Railway Equipment Guide gives the number of cars in use on American roads in 1894 as follows:

Common line and box	526,025

Dairy, dressed beef, beer and milk refrigerators	9,916
Furniture, barrel, chair and carriage	3,880
Ventilated fruit and heater	5,738
Stock cars	56,633
Flats and gondolas	554,588
Logging lumber and gun trucks	591
Oil and water tanks	2,371
	1,159,742
Cars privately owned, about	70,000

Mr. Wheatly gives the cost of repairs and renewals as $50,063,999, or about $40 per car. If our experience, showing that the relation of labor to material is as 1 to 0.75, is a fair average, then there is annually expended in labor $28,608,000 and in material $21,455,999. It was formerly the practice to carry stock on hand for making these repairs to approximately the value of one-half the total annual cost of repairs: hence the stock on hand must be worth in the neighborhood of $25,000,000. By a proper classification of material, working out of obsolete material, checking of supplies and orders, and prompt filling of requisitions (say within 30 days), the stock on hand can be reduced 50 per cent. without detriment to the work.

Recently the practice of working over the scraped material, and reusing it, has grown to considerable proportions. The extent to which this can be carried is indicated by the experience of a shop where, in making repairs to 30,217 freight cars, 81 2-10 per cent. of second-hand material was used. While this source of economy cannot be neglected, care must be taken that more money is not spent in reworking the old material than would purchase new.

The following table discloses one cause of the expense of repairs,—*viz.*, the want of standardizing of material.

BOX CARS IN USE IN UNITED STATES.

Length.	No.	Length.	No.	Length.	No.	Length.	No.
20 feet	275	28 feet	97,668	35 feet	7,079	42 feet	158
22 feet	33	29 feet	39,658	36 feet	10,057	43 feet	15
23 feet	84	30 feet	54,743	37 feet	2,393	44 feet	31
24 feet	995	31 feet	1,338	38 feet	1,639	45 feet	55
25 feet	478	32 feet	30,242	39 feet	957	46 feet	2
26 feet	514	33 feet	134,311	40 feet	5,157	47 feet	2
27 feet	3,615	34 feet	200,533	41 feet	150	48 feet	14

The capacities of these cars run from 20,000 lbs. to 60,000 lbs., and they have a probable value of $313,000,000. Besides increasing the expense of repairs, the old and low-capacity cars decrease the average movement, and make necessary an increase in the total number.

There is chance for economy, both in maintenance and operation, in a revision of this list.

There has been a very satisfactory progress of late years toward an adjustment of both the dimensions and the capacities of cars to needs of shippers. The gain in this direction, as well as over the English practice, is indicated by the following figures:

	Weight of car and load.	Weight of car.	Loaded car to empty.	Weight of car to average load.
United Kingdom ...	8 tons.	5 tons.	1.6 to 1	1 to 0.3
U. S.				
1882	22½ tons.	10 tons.	2.13 to 1	1 to 0.7
1893	43 tons.	13 tons.	3.0 to 1	1 to 1.0

As Evans has pointed out, "large economies grow out of the American system of cars,—two four-wheeled bogies and chilled cast-iron disced wheels, the most economical wheel ever placed under a car." Further economy can be had in the use of supplies, systematic inspection resulting in reducing by one-half the amount of oil and waste. The grade of oil used on many roads is too expensive, comparatively cheap grades of earth-oils giving entire satisfaction.

The joint, notwithstanding all the efforts which have been expended upon it, still continues to be, as it was in the beginning, the weakest point in the structure. To increase the strength of the joint over the angle-bar form in common use, Dr. Alvin Vietor has invented a rail rolled with an unsymmetrical head, so that, when it is scarfed, the full strength of the web may be preserved; instead of entirely severing the rail at the joint, he maintains the full section of the head, and adds thereto two webs and angle bars deepened in their vertical section. But the most profitable field for present economy in this particular lies in the lengthening of the rail, and the consequent reduction in the number of joints. Modern cars permit of the convenient transportation of rails 33 ft. long, and that ought at once to be made the minimum length, thus reducing the number of joints by 10 per cent. Extensive experiments are being made with 60-ft. rail, and it is probable that this is the coming type.

Mr. Reece has shown that the cost of tie renewals, even in the well-timbered States of the Middle-west and North-west, has for some years past exceeded the expense on account of rail renewals. The time has come when we must try to devise some chemical treatment of the cross-tie which will protect it against the disintegrating effect of time and weather. The report of July, 1885, of the Committee of the American Society of Civil Engineers on the preservation of timber, holds out the hope that by Burnettizing we may double the life of the tie. Some three million ties have been so treated on the Chicago, Rock Island & Pacific and Atchison, Topeka & Santa Fé roads, the cost being about 17 cents per tie, or, by the improved Wellhouse process, 19 cents. Against the abrading action of the rail moving under the traffic we may interpose the protection of the tie-plate, the flanges of which, imbedding themselves in the wood in the direction of its fibre, will become an integral part of it, and will enable us to substitute for white oak less expensive woods.

There can be no doubt that, as Mr. Wm. H. Brown suggests, "the cheapest way to operate a railroad is to keep the track in first-class condition all the time." Mr. Dorsey concludes that the average American road can profitably invest $13,167 per mile to improve its road-bed and track so as to operate as cheaply as the English roads with regard to maintenance of way, locomotive power, and repairs to passenger and freight cars. He finds that from 1876 to 1885 there was a decrease of 118 per cent. in materials used on five English lines representing 50 per cent. of the business, and attributes our excessive cost of maintenance to the great amount of perishable materials used, the excessive cost of labor, and the severe winter weather. He calls attention to the small amount of material used on the London and North Western in 1886,—$245,000 against $895,000 in wages, or, say, 1 to 3.65,—and says that English wages are 50 per cent. lower than ours. Their material is perhaps 25 per cent. cheaper, which would change the ratio to 1 to 5.87. It is not possible to get similar figures from the published accounts of American roads, but an analysis of the expenses on my own division for 1892—an average year—gives wages 1, material 1.13. The difference is so great as to throw doubt on the correctness of the figures furnished, but unquestionably our expense on account of material is excessive. The high price and large amount of labor would indicate this as a field promising immediate results, and we find it being vigorously attacked in many quarters. The great success that has attended the piece-work system in locomotive and car repairs has naturally suggested its application to maintenance-of-way work; the large proportion of labor devoted to surfacing track and the relatively small number of "pieces" of work make its success very promising. Trials have been made in Austria and Belgium with but indifferent results, but those being made in this country promise a fair degree of success.

Great care should be taken to sharpen the eyes, and sense of neatness and good looks, of the entire force. Not only is the feeling of self-respect and well-being greatly increased in the employee, but the work is much more carefully done, and there is much less waste of material.

The want of a unit of comparison is felt in considering this class of expense. We measure the oil used in the lubrication of cars by the "thousand miles" run, we measure the cost of locomotive fuel by the ton mile, but we have no standard of comparison for maintenance-of-way expenses. I have seen no suggestion that seems to me an improvement over the method used by Lardner in 1848, which divides the expenses into two parts: (1) those which are appropriate to the repairs of the wear and damage produced by time and the vicissitudes of weather; (2) those which are appropriate to the repairs of the wear and damage produced by the action of the traffic upon the road. Such an analysis of the expenses of two divisions for 1892 gives the following results:

EXPENSES DUE TO TIME AND THE WEATHER.

	Per Mile of Main Track.	Per Mile all Track.
Line A	$1035.00	$607.04
Line B	603.65	380.15

EXPENSES DUE TO TRAFFIC.

	Per Train Mile.	Per Ton Mile.
Line A	$0.139	$0.0004
Line B	0.080	0.0004

Such a comparison might well invite inquiry on the part of the management as to the administration on line A in the items of fences, cattle-guards and road-crossings, bridges, cross-ties, road-bed, ballast, etc.

Under this head may also be mentioned the advisability of eliminating so far as possible the crossings of railroads at grade. Not only do these crossings seriously affect the speed of passenger trains, but they are costly to maintain and operate, and introduce new elements of danger. Here also we may well take account of the rapid increase of grade-crossings of electric railways, the dangers from which have become so threatening that the directors of the Pennsylvania Railroad, in their last annual report, say "they create a new and most serious peril for the traveling public. It must be borne in mind that the entire movement on these electric railways is in the transportation of passengers, and that therefore the risk of life and limb from such crossings, owing to the frequent service, is proportionately much greater than on the steam railways, where the trains are not nearly so frequent, and where the movement is made up largely of freight traffic. It would hardly seem reasonable that the electric railways should be permitted to indefinitely increase the number of crossings, while at the same time your company and the city of Philadelphia are expending over

$400,000 to remove grade-crossings on your road by the North Pennsylvania Railroad in the northern portion of the city."

Considerable economy in operating the traffic can sometimes be effected by changing the location of passing sidings so as to get the benefit of momentum in overcoming adverse grades; stations or telegraph offices often are so located that trains have to back up and take a run for the hill, which they could without difficulty have surmounted under headway. Very often this results in decreasing the train load. Sometimes a change in the rules for taking sidings will overcome the disadvantage of location, but, if necessary, the change in the sidings themselves is usually inexpensive. On a road 100 miles in length with 0.80 maximum grades in average broken country the cost of relocating the passing sidings was $30,000. Of much greater importance is the question of the reduction of the ruling grades, which bids fair to occupy a very prominent position in the economy of the future. Mr. Wellington has pointed out that, "by attacking the work of improving old lines by the method outlined in his work on 'Economic Location,' halving the more formidable and inevitable grades at once by using a pusher on them and spending all our money on what were before the very easy grades and hence are usually in light work, the average train load may be doubled, at small cost, on thousands of miles in this country." More recently Mr. Thompson has shown that the money spent in improvement of track, strengthening of bridges, etc., with that spent in getting heavier engines, if used in the reduction of grades would have produced about the same results in increasing the train load. It seems entirely probable that all the enormous economy growing out of the use of heavier engines will be duplicated in the future at approximately the same cost by the reduction of grades.

WATER POWERS OF THE WESTERN STATES.

By A. G. Allan.

WHILE the subject of irrigation may be the most important issue now before the people of the Western States, the development of the magnificent water powers which nature has so bountifully supplied, and the transmission of that cheap power to localities where it can be used in manufacturing, will, before very long, become the primary object in those industrial circles.

There being comparatively few places in the West where coal is mined, the manufacturer of the Western States, using steam power, can never, except in a few favored localities, compete successfully with the factories of the States east of the Missouri, using cheap and easily obtainable coal. The inhabitants of the "arid regions" now consume many articles made in eastern factories from raw materials grown by themselves.

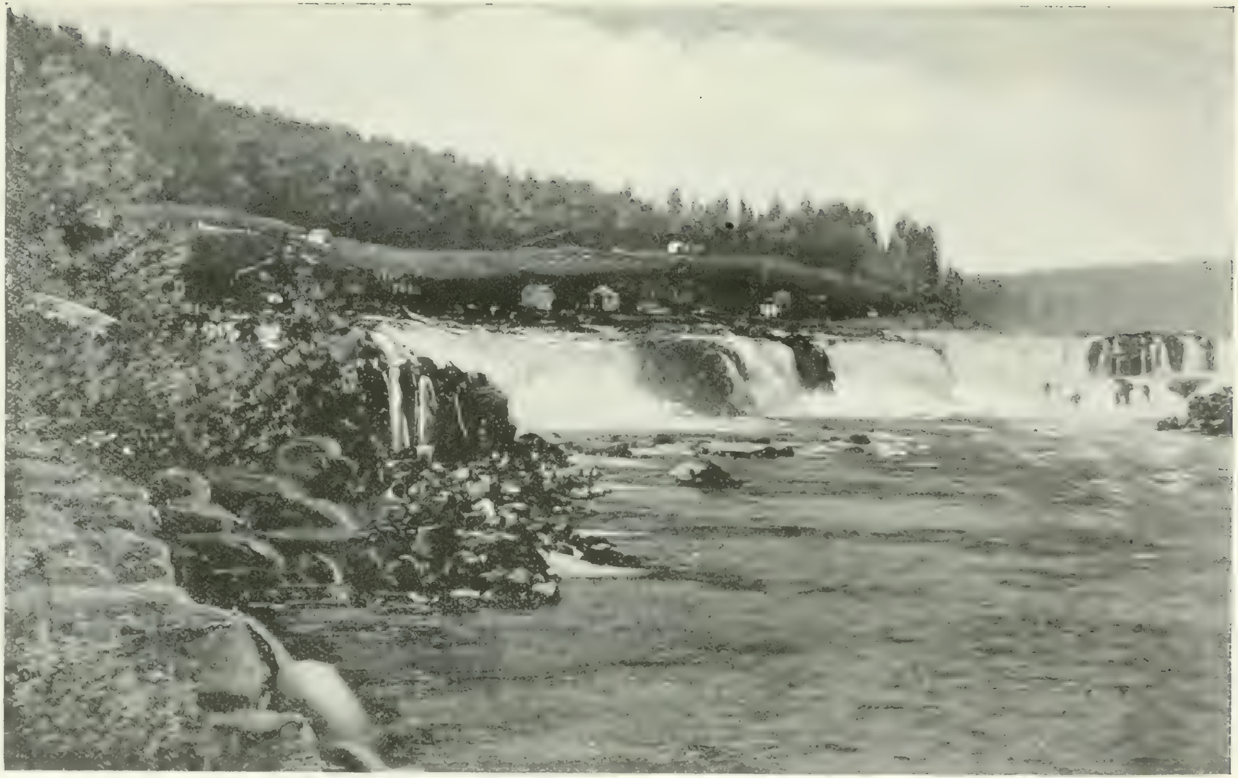
Owners of waterfalls are beginning to realize that this class of property has been largely advancing in value in the past few years. Nevertheless there are yet many opportunities in the Western States for the advantageous acquirement of important water-power privileges.

There are to-day hundreds of thousands of horse power running to waste in the Rocky Mountain rivers and streams, because of their remoteness from centers where the power can be utilized; but, when the question of long-distance transmission of energy by means of electricity shall have been solved,—and in the opinion of electrical experts this is nearly accomplished,—the owners of water powers will use this now wasted force to turn the hundreds of wheels in mills and factories in manufacturing cities, which are now entirely dependent on steam.

An Eastern man lately remarked to the writer: "I do not consider water power so much cheaper than steam power; the waterfall must belong to some one, and, as soon as the owner can obtain a rent for it, he will charge so high a rent that it may just pay the manufacturer to use his water instead of steam power." This might apply to localities in the East where coal is mined in many places over a large area, but the order of things is reversed where coal is expensive and water power plentiful. Property has not the same value in a thinly-settled region that it has in a populous country, and there are many isolated mines and mills (of which two will be shown later) where one year's saving in coal, in consequence of the use of water power, has repaid the entire outlay on the hydraulic installation.

All through the West the smaller water powers have been gradually

RAINBOW FALLS, GREAT FALLS, MONTANA



FALLS OF THE WILLAMETTE, OREGON CITY.

THE FALLS OF JUANACATLAN.

developed to drive flouring mills and electric-lighting plants, as well as to furnish power for some mines. But not one hundredth part of the available water power now wasting its energy is caught and made to do the work which it is capable of doing. In a newly-settled country the smaller powers are always developed first: usually by individuals for their own use, by building log or earth dams across narrow streams, with short races, and cheap wooden gates and penstocks; then gradually by capitalists and corporations, who construct larger and more substantial works as soon as the demand for power will justify the expense.

These rivers originating in the mountains, where the precipitation is large, and flowing from a high altitude to a gently-rolling plain, in a comparatively short distance the river channels form two distinctly different characteristics. The mountainous portion being rocky, the rivers run at a high rate of velocity on a steep grade, through deep, narrow cañons, until they reach the broader valleys below, when they change into wide, shallow, and usually sandy streams. Farming west of the one-hundredth meridian depends for success entirely upon irrigation, the rainfall being insufficient to mature crops, and the amount of arable land being largely in excess of the supply of water. In Colorado, where almost the entire flow is taken from the Platte and

Arkansas rivers and their respective tributaries in the irrigating season, there are, with few exceptions, no large water powers outside of the mountain region. Nebraska is 440 miles long at its greatest length, and 207 miles wide. It is one vast prairie, with an elevation of 5000 ft. above sea level on its western border; it is intersected with about seventy-five rivers and small streams and thirty-four small lakes. The largest river is the Platte, which has a total length of 1200 miles; it is formed by two branches,—the North and South Platte,—their junction being at the town of North Platte in the center of the State. The South Platte has a drainage basin of 24,400 square miles, but, except during a short time in the spring and early summer, no water reaches its mouth, the entire flow being absorbed by irrigation. Therefore all water for power purposes in Nebraska comes from the North Platte. This river, heading in the Colorado North Park, has a computed drainage basin of 35,500 square miles, with a fall at first of nearly 12 ft. to the mile, gradually reduced to 6.9 at North Platte. The only large developed power plants are at Gothenburg and Kearney, respectively 40 and 100 miles east of North Platte.

The plant at Gothenburg consists of a canal 11 miles long, with a fall of 1 ft. to the mile; the river here having a fall of 6.6 ft. to the mile, the available head obtained is 50 ft., and the maximum h. p. 2500. The plant is equipped with a pair of $22\frac{1}{2}$-in. horizontal

WASTE WEIR AT KEARNEY, NEB.

water wheels, and dynamos sufficient to generate electricity for lighting purposes.

The power at Kearney is obtained by means of a canal 16½ miles long, with a fall of 1½ ft. to the mile. The river, falling 7.7 ft. to the mile, gives a head of 60 ft. at the end of the canal, where a large brick power-house is located, furnished with two pairs of horizontal water wheels, a large Corliss engine and boilers, and eight dynamos. The power is utilized to light the city, generating current for thirty arc lights and about two thousand incandescent lights, as well as to furnish the motive power for a large roller flouring mill, two foundries, printing establishments, and numerous small motors. Two miles above the power-house the canal furnishes power for a 15,000-spindle cotton mill, driven by a pair of 35-in. wheels under a head of 35 ft.

There is nothing peculiar in either of these powers, which are due simply to a difference of grade between the canals and the river. The great difficulty is to divert the requisite amount of water into a canal from such a wide shallow river as the Platte, whose currents are changed from one side to the other by high winds, and whose sandy bed absorbs so much water that the visible supply for this great river, draining 60,000 square miles, falls as low as 800 cu. ft. per second.

Coal for steaming purposes costs $3.50 per ton ; so, assuming 1 h. p. to be developed from 4 lbs. of coal per hour, the annual cost per h. p. would be $70 for a 100-h. p. engine working 310 days 24 hours per day. A canal, costing $200,000 and furnishing daily 5000 h. p. for 24 hours, would pay a good dividend daily at $1.00 per h. p. per annum for each hour that power would be used, making power cost $24 per annum for 24 hours daily use, or $10 per annum for a 10-hour daily run, if industries to consume the available power were established.

The city of Omaha has an incorporated water-power company, which has surveyed a canal 40 miles in length, with a capacity of 1500 cu. ft. per second, carrying this to a point a few miles west of the city and giving an available head of 140 ft., and about 15,000 h. p. As Omaha is a manufacturing city of considerable prominence, with a population of 140,000, this power plant will sooner or later be constructed.

A typical prairie mill power is located at C——. This, consisting of a cheap log and earth dam, with a timber over-flow, diverts the water into a race about a quarter of a mile long ; the wheel used is a vertical turbine, set in a wooden penstock, while the power is conveyed to the mill by wire cable. The head obtained is 13 ft., and the mill uses about 40 h. p. Nine out of ten men would not consider the plant of any commercial value, although in reality it has proved a splendid investment. The cost of operating this small mill by steam would be

BEAR CREEK FALLS, NEAR OURAY.

ARGENTA FALLS.

at least $2000 per annum. It is doubtful whether the water plant, including the dam, cost more than this amount for the first outlay; and, with an annual repair bill of one tenth, it runs continuously, day and night.

North and South Dakota are comparatively level, the only range of mountains being the Black Hills. Their elevation is between 1500 and 2500 ft. above sea level, except at the Black Hills, where the elevation ranges from 3000 to 7000 ft. The principal river is the Missouri, which runs through the two States with a general south-easterly course: its fall is only .76 ft. per mile, and consequently the river cannot be utilized for power purposes. The Red river also runs at a low rate of velocity. The James river, a tributary of the Missouri from the north, is about 340 miles long, and has an average fall of 3 ft. to the mile, furnishing plenty of water power. The Big Sioux, rising in the eastern

CAÑON CREEK FALLS.

CASCADE NEAR SILVERTON.

PROOD FALLS, UTAH.

part of South Dakota, forms the boundary line between that State and Iowa for some distance. It is a rapid river, furnishing many small powers along its course, and at Sioux Falls it drops 110 ft. in one mile, furnishing power there for several flouring mills.

There is another source of power in South Dakota, which is peculiar to itself,—*viz.*, artesian wells. The United States Geological Survey shows that under the valleys of the Missouri, as far east as the divide of the James river, there exists the largest artesian basin in the world. The stratum in which the water is found out-crops in the beds of both the Yellowstone and Missouri rivers at the base of the Rocky Mountains, and follows them down until released by the Dakota wells. The difference in the elevation accounts for the high pressure in these wells, which varies from 50 to 200 lbs. to the sq. in. There are now in working operation two electric-lighting plants and ten flouring mills, all propelled by this power. It is a question whether increasing the number of wells will not lessen the pressure, but at present it has not materially done so.

Flour milling is the chief manufacturing industry, the last census giving North Dakota thirty-five mills and South Dakota sixty-two. On account of the high price of coal for steam purposes, these wells are very profitable. The methods of utilizing them are very similar. The water wheel, in an iron casing, is screwed to the pipe which forms the curbing of the well, the volume and pressure being controlled by valves, and the water exhausting into a ditch in which it is drained off. At Northville the water is applied through a 1½-in. nozzle under a pressure of about 100 lbs. to the sq. in. The wheel used is a Pelton, 4 ft. in diameter, with 6-inch buckets bolted to the rim, which drives a full roller-process flouring mill of 100 bbls. capacity. Other wells of the same character are at Yankton, Armour, and Woonsocket.

Colorado contains 104,500 square miles, of which about 32,000 square miles, forming the central portion, are mountainous. It is the highest of the Western States, having a mean elevation of about 7000 ft.; four-fifths of its area is estimated to be between 4000 and 10,000 feet above sea level. The Platte and Arkansas rivers have their sources in the mountains of this State, draining to the East; the Rio Grande drains to the South; while on the West the State is drained by the Grand, Gunnison, Dolores, White, and Uncompahgre, with their innumerable smaller rivers and streams.

In the mountain regions the water powers, remarkable for the very high heads obtained, are usually taken from small streams, or "creeks," as they are called, just before their junction with the larger rivers. One at Telluride has a head of 850 ft.; others near have 320, 425, 500, and 600 ft. These plants are all used for generating electric currents, which are transmitted from 3 to 10 miles, driving motors for mining purposes, and are operated without intermission. Another near Ouray has a head of 485 ft. ; the water is taken from a cañon creek and carried in an iron pipe 4000 ft. long to two wheels, developing about 1300 h. p.

The excessive cost of operating isolated mines at high altitudes by steam power—the coal having often to be packed on the backs of bur-

FALLS OF THE ABRA.

BRIDAL VEIL FALLS.

ros, which makes it cost nearly a cent per lb.—has led mine-owners to develop these water powers, and transmit by electricity to motors at the shafts, the saving in cost of operating being in some cases as much as $40,000 per annum.

At Aspen the electric light company uses eight wheels, giving 1400 h. p. under a head of 820 ft. The water is brought to the power-house in a supply pipe from 14 to 16 in. in diameter. The entire power is used for operating motors at various mines within four miles from the station, and for lighting the town. Under the conditions just described—*viz.*, small volume of water under very high heads—the Pelton wheel seems to be the favorite. There are two other power stations in this vicinity, one using water under heads of 312 and 330 ft., the other having 750 h. p. under a 180-ft. head. At Glenwood Springs one company has a head of 470 ft., the power being utilized to light the town.

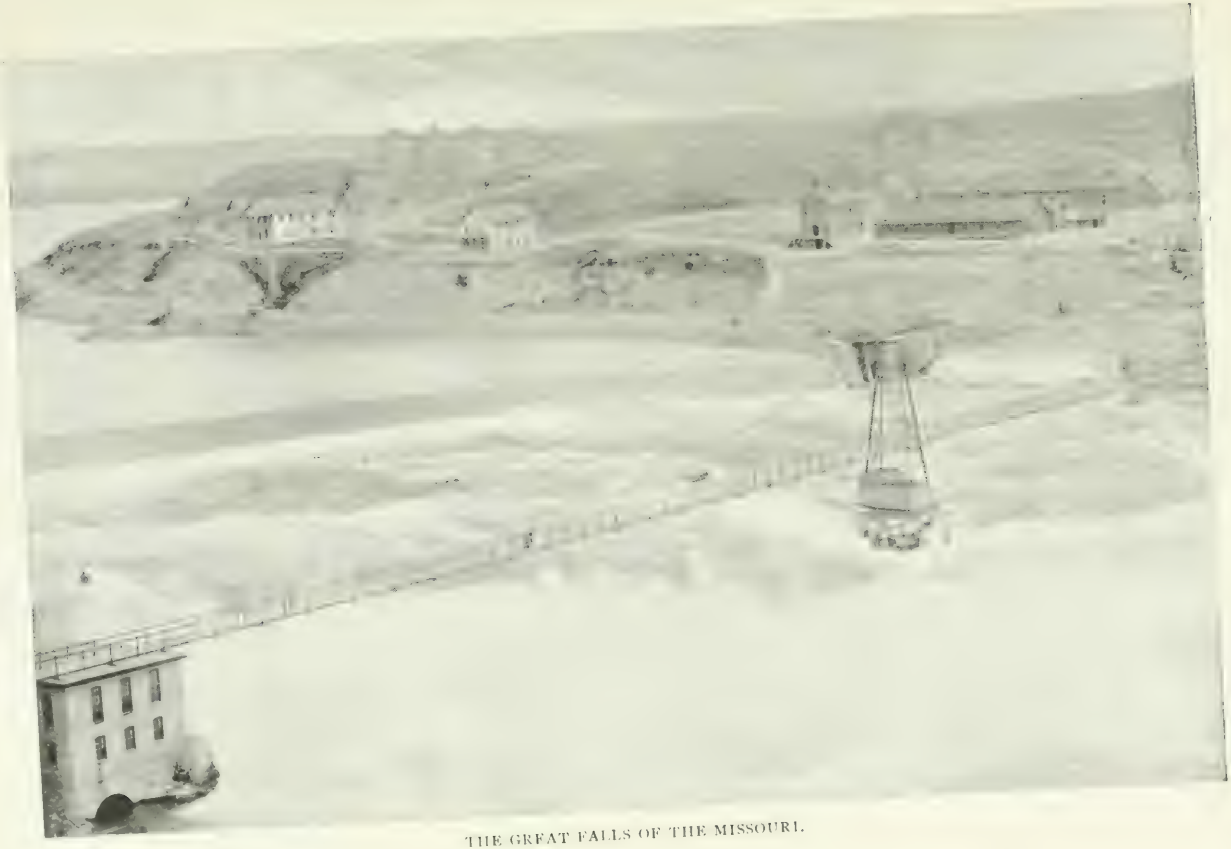
A company has lately been incorporated to develop a water power at Clear Creek, transmitting the power to Denver. There is no doubt that some far-seeing men will eventually furnish the metropolis of the State with cheaper power. There are in Denver flouring mills, rolling mills, foundries, immense smelters, machine shops, cotton and woolen mills, shoe factories, glass works, carriage and harness factories, paint works, breweries, and cable-line, electric-car, and electric-lighting companies, all using steam power at a cost, approximately, of $40 per h. p. per annum, depending on the size of the plant and number of hours run, when there is enough water power in the mountains west of the city to run every factory located there at a considerably less cost per horse power, and leave a profit for a water-power company.

One of the best rivers for large power development is the Grand, the main tributary of the Colorado in this State. It is the largest river in the State; heading in the Middle Park, it cuts its way to the West at right angles with the main mountain ranges, and consequently flows at the bottom of nearly one long cañon, from its source to its junction with the Green. It rises 8150 ft. above sea level, and joins the Green river in Utah at 3900 ft., having fallen 4250 ft. in 350 miles, with a discharge of over 5000 cu. ft. per second. There must be 2,000,000 h. p. going to waste in this river alone. Is it any wonder that the river has cut cañons 2000 ft. deep? Development of water powers is only beginning in Colorado, having been carried out only where the price of coal for steaming purposes has compelled users to seek some cheaper power.

Montana is without doubt the best-watered State in the West, having the Missouri and Yellowstone rivers, with their vast number of large and small tributaries, within its borders. The State is comprised of two parts, the western being mountainous, while the eastern is a rolling plain rising from 2000 ft. at the Dakota line to 4000 ft. at the base of the mountains. The Missouri, heading in the mountains at a high altitude, has a water-shed above the mouth of the Yellowstone of 95,000 square miles. Its principal mountain tributaries are the Madison, Jefferson, and Gallatin, while the Milk and Musselshell join further down, each fed by hundreds of smaller streams. The largest power developed on the Missouri is at Great Falls, where the river runs into a deep gorge with rocky sides, falling here 512 ft. in a distance of 10 miles. The minimum discharge is 1800 cu. ft. per second. A dam and head works costing $275,000 have been built across the Black Eagle Falls, 3 miles from the city, and power-houses costing $150,000 are in operation, furnishing mechanical power, transmitted by cable, to a number of mills and factories. The Rainbow Falls are at present undeveloped, but will soon be used as a motive power for smelting and refining plants. The available h. p. at this point is set at 268,000. The largest smelter located there uses nine single and double wheels from 20 to 48 in. in diameter. The power is transmitted by cables 2100 ft. to the smelter and refinery. Another company uses three pairs of wheels under 40 ft. head. The power obtained is used for electric lighting and for an electric railway 14 miles long, as well as for many smaller motors distributed throughout the city.

The Yellowstone, heading in the National Park (its source being in the Yellowstone lake at an altitude of 7740 ft. above sea level), has a drainage area of 69,600 square miles, and runs for the first 100 miles, after leaving the Park, in a gorge from 350 to 650 ft. below the level of the ground. Its capacity for power purposes is almost unlimited.

Crossing the mountain ranges to the West, we come to Idaho, which lies within the area of the Pacific drainage, only the south-eastern portion draining to the Great Salt Lake Basin. The northern part is very mountainous and covered with timber. The southern is, in general, an arid plain with a comparatively level surface, through which the Snake river has its course. This is the principal river in the State, heading in the Yellowstone Park in Wyoming (where the snow fall is from 5 to 10 ft. deep on the level) and flowing through a deep gorge or cañon, with sides too steep to allow use of the water for irrigation. It is one of the most remarkable rivers in the West. It has a fall of about 4500 ft. from the junction of its North and South forks to its union with the Columbia in Washington, in an alternation, throughout its length, of gently-flowing sections with tremendous rapids and cascades. It falls 50 ft. at the American Falls and 90 ft. at



THE GREAT FALLS OF THE MISSOURI.

the Twin Falls, and, 3 miles below this, at the Great Shoshone Falls it makes a drop of 310 ft. The discharge, as measured by the United States Geological Survey at Eagle Rock (drainage area 10,100 square miles) is a maximum of 50,000 cu. ft. and a mimimum of 4000 cu. ft. per second. It has some large tributaries, of which the principal are the Portneuf, Blackfoot, Boise, Weiser, Payette, Salmon, Owyhee, and

LOWER FALLS OF THE YELLOWSTONE.

SHOSHONE FALLS.

Bruneau. The water powers throughout this section are confined principally to isolated mines and saw mills, one of the best being at Boise City, where a plant under 62 ft. head drives a flouring mill and furnishes the power to light the town. The northern part has some splendid water powers. In the Cœur d'Alene district we find the small cañon creeks, under high heads, developed for mining enterprises. The plant of the Cœur d'Alene Mining Company, near Burke, consists of a flume over 2 miles long, with a pipe line of 15- and 18-inch pipe 3000 ft. long, supplying water to two wheels giving 750 h. p. under 800 ft. head. Other power plants in the locality have 520, 700, and 800 ft. head. The saving in fuel effected in using electricity generated by water power instead of steam has exceeded in some cases, in this locality, $100 per day. In the country draining to the Great Salt Lake Basin there are not as many water powers outside of the mountains as are found on the eastern slope of the Rocky Mountain range, all water being appropriated for irrigation, and the sections where there is any water being thickly settled.

Wyoming has a mean elevation of 6400 ft. above sea level, and contains the Rocky Mountain range passing north from Colorado, part of the Black Hills, the Big Horn Mountains, the Laramie and Wind

SHOSHONE FALLS.

River range, and others. This mountain area is estimated to be, approximately, 35,000 square miles, on which there is an average annual precipitation of 36 in. of water. There are three hundred rivers and creeks within the State. The principal are: on the east slope, the Platte; on the west, the Snake and Green; on the north, draining to the Yellowstone, the Powder and Big Horn, with their respective tributaries. All the streams east and west of the Big Horn Mountains are rapid and not liable to variable extremes. The fall per mile is large, and this section has some fine water powers used for mining and saw mills; but it is sparsely settled, lies at a high altitude, and is practically destitute of railroad facilities.

Washington, with its many diversified industries and climates, is divided from North to South by the Cascade Mountains, which range from 6000 to 10,000 ft. above sea level. As the snow-fall on the mountains is large, and the annual rain-fall is from 70 to 120 in. on the coast, the amount of available h. p. wasted in the rivers draining to the Columbia is almost unlimited. The largest power developed at present is at Spokane Falls, where the Spokane river, leaving the higher ground for the valley of the Columbia, tumbles in a succession of falls 157 ft. in half a mile. Every mill and factory located there, including the water-works company and cable railway, propel their machinery with this magnificent power. It is estimated that to furnish the power available and in use at this city by steam would cost $4,000,000 per annum.

A company has bought, and is preparing to utilize, Snoqualmie Falls, 23 miles east of Seattle, to furnish electric power to that city and Tacoma, and smaller adjacent towns. The height of these falls is 268 ft., and the energy is estimated at 51,600 h. p. Seattle and Tacoma have a number of different manufacturing establishments and cable, electric-car, and electric-lighting companies, all dependent on steam. The two cities use about 10,000 h. p. at a cost of $60 per h. p. per annum, while the city of Everett consumes 1500 h. p. at an approximate cost of $65. If electricity generated by this water power was used instead of steam, it would result in a saving of at least $300,000 per annum to consumers.

Oregon, like Washington, is divided by the Cascade range, which has an average breadth in the State of between 50 and 60 miles, with an approximate height of 8000 ft. The annual rainfall on the Pacific side of the mountains is between 50 and 67 in., by far the larger proportion falling in the winter season. The principal rivers are the Willamette, Yamhill, Umpua, and Rogue on the west side of the mountains, with the Des Chutes and John Day on the east. The largest power developed is on the Willamette at Oregon City, fifteen miles from Portland, where the river has a fall of 40 ft. A power-station has been built, equipped in twenty sections, each section having a large dynamo coupled directly to a 42-inch Victor wheel, with a 60-inch wheel for emergency uses in periods when the river backs water. The total energy obtained is about 12,000 h. p., and the amount of water used is about 5000 cu. ft. per second. The power is transmitted to the city of Portland, being used principally for street-car propulsion, including an electric railway to Oregon City. It would be impossible to enumerate the available water powers in this section of country close to the Columbia. The writer has seen three mills, each using heads of over 25 ft., one below the other on the same creek, only a few hundred yards apart.

The great mountain range of California is the Sierra Nevada, some

SPOKANE FALLS, WASHINGTON.

SNOQUALMIE FALLS, STATE OF WASHINGTON.

of its peaks reaching heights between 13,000 and 14,000 ft. above sea level, while the coast range varies from 6000 to 8000 ft. in the northern part, decreasing to hills in the southern. The average snow-fall, being from 60 to 70 ft., gives, at the ratio of 11 ft. of snow to 1 ft. of water, from 5 to 6 ft. of water over an area of 6400 square miles, at a height of more than 8000 ft. above sea level. The rivers, highly developed for power purposes, have their source in this great Sierra Nevada chain draining to the Sacramento river. Owing to the enormous price of coal, and the number of quartz mines now being operated throughout the mountain region, the smaller water powers have been well developed, while the immense canals with their flumes and pipe lines, originally built for hydraulic placer mining, are being also used by many mines for power purposes. The immense systems of these hydraulic works is appreciated when one considers that the total amount of money invested is over $100,000,000, and that in one county there are 489 miles of canals built at a cost of $3,000,000. Mines using water power from this source pay 18 cents per inch for 24 hours, which makes the cost per h. p. according to the head obtained—300 to 600 ft.—from 11 to 25 cents per day. The only paying mine depending on steam power gives the cost of a h. p. per day at 46 cents; so, notwithstanding the high price charged for water, there is a saving over steam of from $25 to $50 per day. The plant of the San Antonio Electric Light and Power Company transmits power 15 miles to Pomona and 30 miles to San Bernardino, being at present the longest power-transmission line in this country. The power is obtained from a cañon creek, which has a minimum discharge of 21½ cu. ft. per second, supplying four wheels developing 800 h. p. under 400 ft. head. Another important plant is one now being constructed by the Folsom Water Company to transmit electric currents 18 miles to Sacramento. A dam of splendid proportions, 650 ft. long and 89 ft. high, containing 48,500 cu. yards of solid masonry, turns the American river at a point 210 ft. above sea level into a canal 50 ft. wide and 8 ft. deep, constructed for furnishing power to the State prison, and for irrigation. The fall at the prison is 7.3 ft.; the wheels used are 37 in. in diameter, giving a maximum of 1300 h. p. The fall is over 80 ft. at the Folsom end of the canal, where four pairs of horizontal wheels are to be placed, making 4800 available h. p., of which 3000 will be transmitted to Sacramento. A company has been incorporated to furnish San Francisco with electric currents, generated at Clear Lake about 75 miles from the city. San Francisco has 300,000 inhabitants, and manufacturing establishments which consume about 60,000 h. p. at a cost of $7,200,000 per annum. The cost of a hydraulic and electrical plant to deliver 20,000 h. p. to the city is estimated at $4,000,000.

MUNICIPAL OWNERSHIP OF PUBLIC CORPORATIONS.

By M. J. Francisco.

UNDER our present systems of government the number of public officials is limited. In order to increase the list and enlarge the field for political corruption and power, a movement has been inaugurated demanding that governments (State, national, and municipal) shall own and conduct all large commercial enterprises. If this plan could be carried out, the political offices to be filled would be multiplied a hundred thousand times. Then the great army of officials necessary to manage the railroads, telegraphs, telephones, express companies, and gas and electric-lighting establishments, with hundreds of other branches of business that the advocates of municipal ownership would bring into the field of politics, would be changed at every election. This would place the country under the control of a vast army of office-holders, whose only aim and object in life would be to retain their grasp upon office, regardless of the welfare or best interest of the municipality or nation. We are told that by this plan we should secure better results with less expense. What is the record of government, State, and municipal ownership during the century that is closing?

In 1815 the net revenue of the English post office was about $8,000,000, and continued at this rate for 20 years. The people at this time were opposing this government monopoly and the tax to sustain it, as it appeared that the charge of 14 cents on each letter resulted in an expense for postage to some London houses amounting to $50,000 per year. To avoid this private parties established a "penny post," but the government suppressed it, notwithstanding the number of letters sent by post was only as one to ten sent by private means. This shows conclusively that the object of the English post was revenue and State surveillance, rather than a means of benefiting the masses.

The United States post office department is often cited as an illustration of the success of government ownership. Where would the benefits of the post office be, were it not for the aid of private corporations who transport and deliver the mails,—the most important part of the whole process? This is not done by the government, but by private capital representing millions of money. The power of the post office department has been used as a vast political machine for rewarding friends, and the *Boston Transcript* states that "the month preceding the presidential election the greatest percentage of removals was made of any month for four years; whole lines were stripped of their experienced men, and the creatures of politicians were put in their places."

We will not consider the abuse of which the telegraph is capable for political purposes when in the hands of the party in power. It is conceded by all who have made it a study that private management renders better service, with lower rates and more accurate delivery, than can be obtained under government control.

A member of the New York Associated Press, one of the largest patrons of telegraph companies in the world, says that "the average time of transmission on the Western Union Company's lines is shorter than on any European system, and the number of errors made by American operators is much smaller than by European operators." Errors in this country average only about the fiftieth part of one per cent., but in Europe they are so common that the *London Times* said "the government telegraph was a failure," and that "it can hardly be doubted that, if the telegraphic wires of the country were in the hands of private companies and were administered by private enterprise, instead of being a government monopoly, the public would gain largely in rapidity, cheapness, and extension of telegraphic communication."

Experience shows that in Europe and America State aid to railroads has resulted in immense losses. Most of the State railways in Austria, after an unsuccessful trial, were sold to private corporations for about half of their real cost. Mr. Kapp, in a letter published in *The Nation*, referring to government ownership in Germany, says: "Henceforth it will be advisable for a railroad employee not to vote otherwise than in accordance with the political opinions of his chief. Railroad officers, post-office and telegraph clerks, no longer dare to petition in their own names to the Reichstag, because they are threatened with punishment if they do so." In Italy the government took the system into its own hands, but, the gross receipts being continually less than the expenses, a special commission was appointed to investigate, and, after the most thorough and careful investigation ever made, it reported that "State railroads did not as a rule do so much for industry as private railroads; that, in general, their rates were higher, their facilities worse, their responsibility less, while the State railroad management was more apt to tax business than to foster it: political considerations were brought into matters of railroad construction and management in a way which was disastrous alike to railroads and politics."

The plan of investing State funds in commercial adventures has been repeatedly tried in this country, and in every case has proved disastrous. Massachusetts invested $18,000,000 in railroads, and saved only $6,000,000. According to the State treasurer's report, nearly one-half of the State debt of Massachusetts was caused by the State's connection with railroads.

The investment necessary to enable the government to own all the railroads, telegraphs, telephones, and gas and electric-lighting companies in the United States would amount to over $50,000,000,000 and require an army of over ten million employees. It is easy to foresee the effect upon business that would result from a change in this army at every election.

No one can deny the disastrous result upon any service of placing incompetent political tools in charge of it and frequently replacing them by others equally unfit. The history of this country under "the spoils system," with the wild scramble for office after every election, is positive proof that this plan would be carried out in all branches of service. The men who had become accustomed to the business would be turned out, and new politicians and bosses, utterly unacquainted with the work, would be appointed to take their places until another change, and so on, *ad infinitum*.

All the railways in the United States may not have been successful, but it is a fact beyond dispute that under private management the freight rates have steadily fallen in the interests of the people, and that this country commands the cheapest rates of any nation in the world.

The same conditions exist under municipal ownership that are found under government or State ownership, but on a smaller scale. Judge Dillon says: "Our large cities are encountering the perils of corruption and fraud on a gigantic scale engendered by the large revenues and official patronage at their disposal, and the disinclination—often the steady refusal—of the substantial citizens to take a controlling part in the management of municipal affairs."

The public debt of the city of New York represents a vast aggregate of moneys wasted, embezzled, or misapplied, and the disclosures before the Lexow committee ought to be sufficient to prevent for all time any enlargement or extension of municipal patronage and corruption. Philadelphia's corrupt management of its gas works, which involved the tax-payers in a loss of $3,500,000 in six years, is another illustration.

No wonder Judge Dillon said: "The legislature should be prohibited from allowing municipal corporations to engage in extra-municipal projects, or to incur debts or levy taxes for such purposes."

Committees, unacquainted with the business and with no practical experience in electrical affairs, are appointed by city councils to investigate and ascertain the cost of producing light in cities owning plants. This is done with a view of purchasing a plant. The worthlessness of such information and the unreliability of such investigations have been demonstrated times without number. They go to the officials of other cities, who have no knowledge of the science of electricity or its practical application, and whose information regarding the working of their own city's plant has been obtained from employees who owe their appointment to the influence of some political wire-puller whose interest it is to show a minimum of expense. Statements of this kind are used as authority regarding the cost of municipal lighting, notwithstanding the fact that they are discredited by men who have made it a study for years, have thoroughly tested every branch of the business, and are not beholden to a political boss for their position.

A party having a suit in the United States supreme court would not employ a carpenter to take charge of the case ; neither would he go to a hod-carrier for information regarding the running of the "Empire State Express" ; but it is precisely by such a policy that advocates of municipal ownership govern their action. The representative of some manufacturer interviews the mayor or aldermen, furnishing a glowing account of a system by which electric lights can be produced for a mere trifle (provided they adopt his plan) ; then he refers them to other cities where the mayor and aldermen have been worked in the same way, knowing nothing whatever about the business or its practical application, having adopted it through the influence of some other party working either for pay or a "political pull." A few politicians are hired to boom the plan, and make speeches favoring it at the public meetings that are to be called. Garbled statements as to cost in other places, giving about half the expense, are provided. In this way the tax-payers are hoodwinked into voting for its adoption, and the sale is completed. The agent then starts for another city to repeat the same operation, and refers the aldermen in this new field to the last place which he has worked, informing them that, after a long and thorough investigation, his plans were adopted.

The fact that one city pays double the amount for the same grade and make of apparatus paid by another indicates that the cost of aldermanic influence was greater in the former than the latter city ; but the tax-payer furnishes the money to pay for the plant, as well as all money spent in buying aldermen's votes.

The tax-payers in many places where municipal plants are found (furnishing lights to private parties at a price less than the actual cost of producing them) do not seem to realize that they make up this expense and loss to the city, in order to benefit a few citizens who use these private lights. A large proportion of the people in a city who do not use electric lights are taxed in this way for the benefit of a few who desire this luxury in their residences or places of business.

The *New York Sun*, in an editorial upon the subject, says: "Why may it [the State] not proceed to take and run the railroads and express companies, to work the mines, and then go on to the management of all manufactures, and finally to the control and monopoly of all business, to the entire destruction of private enterprise? Then everybody who worked would be in the government employ, prices would be regulated by government, individual enterprise would be gone, and with it would go the liberty for which mankind has ceaselessly struggled through so many centuries. The Roman empire made about the same experiment in the fourth century, with the consequence that, not only the empire, but also society itself went utterly to pieces."

The experience of the most sagacious men in the nation shows that municipal ownership is not conducive to the best interest of any city. Professor Ashley of Harvard University, who was at Toronto at the time the changes were made in municipal management there, says: "I am thoroughly in favor of private management. I came to this opinion after four years' experience of Toronto city government, starting originally with a very strong leaning toward municipal management."

It is only necessary to give the experience of cities which have tried the experiment to show the worthlessness of the claim that municipalities can produce light at less expense than private corporations. As an illustration of this, I will refer to Wheeling, West Virginia, which recently installed a plant of four hundred arc lights to burn all night, using steam power, coal costing $1.00 per ton. Before this municipal plant was established, the local company offered to furnish any number of lights that might be desired, to burn every night and all night, for $72.52 per lamp per year. Parties in Wheeling who had political aspirations made the claim that a plant could be installed for $26,000. This was afterwards raised to $40,000 and again to $60,000, while the actual cost proved to be $125,000. The advocates of municipal ownership represented to the tax-payers that the total cost of running four hundred arc lights, if the city owned the plant, would not exceed $14,000 per year, being $35 per lamp. They adopted the plan, and bonded for $80,000 at 6 per cent. interest, besides using $22,233 of the gas-works' funds (owned by the city) in installing the plant. The principal was payable at the rate of $8,000 per year. Six dynamos were installed with five circuits, one dynamo to be kept as a spare machine. Soon after starting, the armatures began to burn out; lamps were taken off in the hope of relieving the dynamos, thereby stopping the heavy loss; but this did not answer the purpose. In 1894 it became necessary to buy another dynamo and cut down the number of lamps on each circuit, making six instead of five. The city clerk, on page 4, reports the cost of maintaining lights one year at $30,142.42. This does not include interest, depreciation, taxes, insurance, or water rent. During 1893 the funds of the gas trustees were exhausted; a coal bill amounting to $15,659.15 could not be paid, as the city authorities had been allowed to use $22,233 of the funds in constructing the electric-light plant. In view of the city's heavy indebtedness, and the fact that its finances were so low that it could not pay the interest or the $8,000 of principal on bonds which were due, the bondholders agreed to extend the payment of interest and bonds another year. The fallacy of the claim made by the advocates of municipal ownership that the entire cost of running the plant for a year would not exceed $14,000 is shown by the actual experience for a year, during which time the pay-roll alone amounted to $17,191. The tax-payers have learned the truth regarding municipal ownership, and there is trouble; the constant refrain now heard is the "electric elephant on their hands." This is one illustration of the results produced by adopting the unreliable reports and figures used by the advocates of municipal ownership. Experience is a very good teacher, but sometimes rather expensive; and, when the authorities found that it was costing them $112.73 per lamp per year for the same light that the local company offered to furnish for $72.52, they no doubt would have cheerfully dumped the parties whose advice they had followed into one of their huge political machines to see if it would increase the number of amperes required and decrease the steady loss.

Statements have been scattered broadcast by the advocates of municipal ownership that the entire cost of light at Little Rock was only $51 per lamp per year. Many cities and committees have based their calculations upon this statement, and voted to adopt municipal ownership because the expense, as shown by reports from Little Rock, was so much less. Upon investigation, it appeared that two reports were made by the authorities of Little Rock, one of which gave a glowing account of the electrical business. The other seems to have been made for the information of the aldermen only. On page 17 of this second report, the city clerk says: "In compliance with your request, I have made a comparative statement of the expenses of this department. The statement made by the city clerk in January must be corrected, notwithstanding the report has gone out that this city has been running its lights for $51 per lamp per year. The expenses for this year are $8,043 84, which equals $80.43 per lamp per year." This report was made to the mayor, and shows that the cost of lights until midnight, on moonlight schedule, not including interest, depreciation, insurance, taxes, or water rent, was $80.43 per lamp per year. The city clerk also plainly states that the previous report, which had been scattered broadcast, was false. The Kansas City committee were informed that the total cost of lights was $47.45 per lamp per year, and the Hamilton committee were given $69.83 as cost, while the Evansville committee were told that the cost was $70; and the superintendent states, in his report to the mayor for the same year, that the cost was $80.43 per light. The statement that was sent the committee of Kansas City, showing that lights only cost $47.45, has been produced by the advocates of municipal ownership before almost every city council that has called for the cost of lights at Little Rock. The mayor, in his message (page 5 of city report), says: "The electric plant is composed of old antiquated machinery." This statement was made by the mayor only three years after the plant was installed, and thereupon an appropriation of $30,000 was made for repairs and new apparatus, although, as the report shows (page 18), $9,622.70 had already been spent for repairs. Here we have the record of a municipal plant after three years' use, and, if we add the expense of repairs to the $80.43 which the superintendent says the lights cost, we have a fair illustration of the benefits to be derived by a city attempting to manage a commercial industry.

Judge Cooley well says: "In a large number of cases the anticipated benefit was never received, and, as is likely to be the case where municipal governments take part in projects foreign to the purpose of their creation, it has furnished unusual facilities for fraud and public plunder, and led almost inevitably at last to discontent."

The facts cited above show the practical working of municipal plants. The same analysis could be made of nearly every one in existence, if space permitted, with the same general result.

The political record of this country shows conclusively that the constant changes caused by alternating party triumphs must destroy all interest in governmental enterprises on the part of those in charge of them, who well know that they hold their places only during the term that must elapse between elections. The politician who wins will reward his friends by placing them in charge, regardless of the fact that they have had no experience in the business. In this way the mechanical and other details that must be carefully watched and guarded in order to make the enterprise a success are neglected, and the tax-payers wonder why the mysterious power called electricity eats up so much of the public money. The council of the city of Philadelphia made a very extensive investigation of the subject of municipal ownership, calling upon the best-posted men in the country for their experience, and also securing the testimony of experts, which filled over one hundred and forty printed pages. Specifications of the cost of installing a plant were demanded. The director of public safety employed an expert to make specifications, and it was estimated by him that the total cost would be $97,360. The chief of the electrical bureau made specifications, which placed the probable cost at $100,510. Mr. Cowling made specifications, showing a cost of $221,907.50. The committee made specifications, showing a cost of $251,763. Here we have the estimates made by four different parties, all based upon the same number of boilers, engines, and dynamos,—in fact, every one was for precisely the same capacity of plant,—and the difference between the estimate made by the council committee (some of whose members were practical electric-light men) and the estimates made by the city director and his expert, who were in favor of municipal ownership, was $154,403. After this, the most thorough and most complete investigation of the cost of electric lighting ever made in this country, the council voted against municipal ownership.

This shows plainly that, when an honest investigation is made, it will convince any board of aldermen who are acting for the best interest of their city and its tax-payers that it is their duty to oppose municipal ownership.

A college professor without practical experience or knowledge of the business published a text-book for use in schools, in which, on page 302, he made the statement that the cost of electric lighting, when a city owned the plant, was 33⅓ per-cent. less than when lights were furnished by a private corporation. As an illustration, he cites the city of Rutland, Vt., stating that the private company compelled the city to pay $280 per lamp per year, and upon this basis he shows a saving of 33⅓ per cent. in favor of municipal ownership.

What are the facts in *this* case? The city referred to, in which, according to the professor's statement, the lights cost $280 per lamp per year, has paid during the past five years an average of only $89.40 per lamp per year, burned every night until midnight, and this, too, with the poorest quality of soft coal, costing $4.50 per ton.

As the writer has checked every lighting bill paid by the city during the above time, he knows whereof he speaks. Still, the statement made in this text-book, in which the cost of lights per lamp per year is placed at a figure exceeding by $190.60 the price actually paid, has been copied and sent broadcast as an illustration of the benefits of municipal ownership and an argument for its adoption.

The time for municipalities to own and conduct commercial industries has not arrived, and will not arrive until men are born into a world where politicians and aldermen protect tax-payers and refuse "boodle"; when children are removed from parental influence and nurtured by the State, as advocated by Plato; when employees, with no interest in the business except to aid the political bosses and draw their salaries, can conduct the business more economically and successfully than men who have perhaps every dollar of their fortune depending upon its success; when, in fact, the millennium arrives, and the whole human family is transferred to some eternal city lying beyond the misty shore of time. Until that time comes, let all cities confine their business to regulating and governing, leaving commercial industries with their hazards and losses to individuals and private corporations.

THE CONTROL OF PUBLIC-SERVICE CORPORATIONS.

By Allen Ripley Foote.

> "Let all cities confine their business to regulating and governing, leaving commercial industries with their hazards and losses to individuals and private corporations."
>
> *M. J Francisco.*

I AM asked to prescribe a remedy for existing evils growing out of the relations between municipalities, municipal public service corporations, and the users of the services rendered by them. A true settlement must be one that will correctly balance the interests of all these factors, and give to each the advantages it can justly claim.

The first principle to be recognized is that the greater interest must always control the lesser. Upon this principle government by the majority is founded. A public improvement, such as widening a street in a congested portion of a city, may cause many individuals much inconvenience and loss, for which no compensation is provided; but, being a direct advantage to a much larger number of persons and of great general advantage to the municipality as a whole, the few must acquiesce to the convenience of the many, and permit the work of widening the street to be done.

There is but one limit on the rule of the majority. That is, its action must be just. This limitation circumscribes every person, and every group of persons from the smallest combinations to the greatest nations. To establish justice governments are organized. When justice is established, a correct balance will be firmly maintained between the interests of the municipality, of the corporations, and of the users of services, so that the relations between them shall be those of mutual benefit and helpfulness. In the domain of justice it is impossible that any person or group of persons can be permanently benefited by their own acts of injustice. If this were not true, there could be no justice.

It is not good business to secure a temporary advantage at the expense of a permanent advantage. That which is for the moment an advantage may, in the larger view, be seen to be a loss. A burglar may have a temporary enjoyment from his ill-gotten gains, but it is impossible that he should permanently improve his life in such a way. Attempts to secure more, or to give less, than justice requires are the cause of all the injustice from which mankind suffers. What municipal public-service corporations shall give for what they receive; what the users of the services rendered by them shall receive for what they pay; how collective municipal interests shall be benefited by the collective demand guaranteed to corporations through granting them special privileges,—are all questions that cannot be correctly settled, and from the settlement of which no permanent gain can be made, unless they are settled in strict accord with the requirements of ethical and economic justice. A gain of high value will be made when this fact is clear to the perception of every one.

Coming now to practical considerations, it must be apparent to every one that all factors of uncertainty increase the cost of doing business: therefore all acts of commission or omission which result in uncertainty as to the perpetuity or the exclusiveness of the business of a public-service corporation must increase its price for the services it renders. The increase of a price for such a reason is an unjust tax on the users of the service, because it is unnecessary. A striking illustration of the cost of uncertainty is furnished by the sale of sixty-two millions of United States *coin* bonds to draw 3¾ per cent. interest, when the buyers offered to accept *gold* bonds at 3 per cent. interest. Had congress ordered $16,000,000 of gold taken from the treasury and sunk in the ocean beyond the power of recovery, the economic result for the people would have been the same as now; but the indignation of the people would be overwhelmining, because the directness of the plunder and wanton waste would enable them to understand the injustice of the act. As it has been done, the indirectness of the effect and the slowness of its manifestation permit the people to sleep while the blood is quietly sucked out of their economic system.

In the organization and control of municipal public-service corporations the chief factors of uncertainty that can be at once eliminated by the repeal of unjust and the enactment of just laws are those regulations limiting the duration of the corporation, limiting the time for which it may make a special use of the highways or privileges where its plant is located, and then adding a guarantee that it shall not be encroached upon by any competing organization. In every department of endeavor the expectation of securing a future good is the energizing power relied upon to stimulate right doing. Justice requires that faithful and efficient service shall be the royal title to the right to perform the service as long as it may be required. Such an assurance is the only condition that will justify a workman in yielding up his life in preparation for and in doing perfect work in any vocation. Such a condition is the only one that will justify public-service corporations in providing the best constructions and equipments known to their art,—which are safer, more reliable, and less expensive to maintain than those built for a comparatively temporary use. The regulations should require a corporation organized to supply a special need to construct works designed to supply the need as long as it exists.

The chief objection to granting exclusive franchises is found in the belief that competition is necessary to force low prices. But in the domain of governmental economics we have an effective substitute for competition in the right to control charges by means of wisely-devised systems of arbitration. In determining the price a corporation should charge for its services, justice requires an examination of all evidence offered and will permit the cross-examination of every person giving evidence. Its findings will be based upon the ascertained necessary cost of producing the service, plus a fair return for the interest and profit of the capital employed. Such a method will give to a municipality and to the users of the service the full advantage of favorable local conditions of which it may be the fortunate possessor. It will assure the corporation just treatment and relieve it from the expense of lobbying municipal councils or State legislatures in behalf of a fiat price, which it will naturally endeavor to secure at the highest rate possible. Being assured of a continuous right to supply the service, and of just treatment in the price it may charge, the corporation can enter upon the work of furnishing the best known service at the lowest practicable price, with confidence in its immunity from bloodsucking ordinances in city councils or bills in State legislatures. These conditions will relieve it from all unnecessary burdens, such as free service, lobbying expenses, large attorneys' fees, and newspaper protection. Being protected by just laws, it will need no other protection. The fact should be recognized and acted upon that a just price, to be charged by public-service corporations, includes justice for the users of the services as well as for investors in such undertakings; and further, that the determination of a just price is a judicial, not a legislative, function.

The volume of service is an important factor in determining cost. Competition is supposed to stimulate demand through reducing prices. There is a limit, however, to the demand for any service within a specified area. It is not possible for two plants to render a service as cheaply as it can be done by one that could control and supply all the demand within the reach of both. The inevitable result of a multiplication of plants is an increased cost resulting in an increased price, or in a loss on the investment. The first is unjust to the users of the service, the last is unjust to investors in the plants. Uncertainty resulting from short-time contracts, limited life of the corporation, and lack of protection in its area of operation is a far more serious source of evils than a superficial observer can be made to understand.

The city of Baltimore furnishes an object lesson for those who suppose that prices can be permanently reduced by the methods of competition. In unintelligent efforts to secure low-priced gas, franchises have been granted to one competing company after another, until six gas plants, more or less complete, have been built in that city. One after another the competing companies have died, until now there is but one company owning all the works, doing business on an investment several times larger than is necessary.

It has been supposed that it was necessary to leave a margin for speculation in drawing regulations controlling such organizations. This is a mistake. Every element of speculation is one of uncertainty. Every factor of uncertainty retards the investment of capital and enhances the cost of obtaining it. Remove all uncertainty, and capital will clamor for the privilege of an investment in the stocks and bonds of public-service corporations, as it did recently for an opportunity to invest in United States bonds, and at no higher rate of interest. Economically considered investments in the stocks and bonds of productive industries should be as safe as, and more profitable than, investments in political mortgages. The only reasons why they are not so are found in the unintelligent conditions imposed upon, and privileges granted to, them by those who legislate for the people. National banks are organized and inspected under a uniform system. Their managers, investors in their stocks, and their depositors are all vitally interested in keeping them in a sound condition. These three classes include the best business men in every community. If experience has taught the necessity for uniform organization and independent auditing in the case of national banks, is it not fair to assume that important gains can be made for municipalities, municipal public-service corporations, and for the users of the services rendered by them, by a uniform system of organization, accounting, independent inspection, and auditing by State authority?

Such a system would make scientific statistical comparisons possible. It would induce competition, not between corporations in the same city, but between cities to show best results for money expended. The rewards would be growth of cities with a resultant increase in the values of property and volume of business, better service at decreased prices for users, better managed, and more surely profitable corporations.

All the evils complained of exist because there is no well-defined public policy, based on correct economic principles, by which legislators are bound to square their actions and upon which managers of corporations can depend for the protection of their business interests. On account of this deficiency, legislation is in a chaotic condition, and government, instead of being honestly and intelligently directed, is guided by prejudices and guessing. This is the cause of the dissatisfaction and antagonism existing between municipalities, corporations, and users of services. The self-interest factor in each is not properly adjusted to that of the others. This throws the whole economic mechanism out of order. The result is unnecessary friction, irritation, and loss. A remedy for the evils must deal with the broad question of public policy rather than with specific cases, which are simply local symptoms of a universal disease. The energizing force of self-interest pervades municipal, corporate, and individual action. Properly to settle the problem, the forces of self-interest actuating the factors must be so balanced that at no point will antagonism be developed, but at every point of contact there will be reciprocal benefits and an augmentation of energy. The factor of greatest importance is the self-interest of the users of services. From their patronage is drawn the life-blood of the industry. Upon their prosperity depends the prosperity of the corporation, of the municipality, of the State, and of the nation. The interests of the users of service is satisfied by having service rendered in the best known manner at the lowest practicable price. This desideratum, I maintain, can only be established through properly organized and regulated public-service corporations owning and operating the plants as a profit-producing industry. The requirements for proper organization and regulation are:

Uniformity of organization, accounting, independent inspection, and auditing required by the State. In the absence of any general State laws, then the organic municipal charter should be amended to provide for these conditions.

No issue of stocks or bonds should be permitted except for tangible value necessarily employed in the organization, purchase, construction, equipment, or operation of the plant.

No charge should be permitted for franchises or privileges of any kind.

No limitation should be placed on the life of the corporation, or upon the time during which it may supply the services it is organized to render.

No taxes should be assessed upon the property, business, or income of the corporation.

No competing company should be permitted to divide patronage within the area served by an existing corporation.

Prices charged for services should be adjusted from time to time on the basis of cost of production, plus interest on capitalization, at the rate paid by the municipality on its bonds, and a reasonable profit.

All surplus earnings should be used to retire bonds, without permitting a capitalization of the values represented by them; or, if no bonds, for extending the plant, without capitalizing the investment.

Under these conditions services can be rendered in the best known manner at the lowest practicable prices, and the corporation stocks and bonds will be the best investments in the world, because the self-interests of the corporations and of the users of the services they render, will be well secured, and the municipality will enjoy the best economic advantages that science and art can devise.

If State and municipal authorities cannot properly regulate and control public-service corporations under these conditions, how will they acquire the ability properly to invest taxpayers' money in the construction and operation of municipally-owned plants or works? Many people honestly suppose that good services at low prices will result from public ownership. This fallacy has gained ground by appeals to prejudice instead of judgment, and very largely by imperfect and misleading statements of the results of municipal ownership. A brief analysis and comparisons of conditions will show that the expectation of making a permanent gain over private corporate management by means of municipal ownership must inevitably be disappointed.

When a government undertakes a business, its function of regulating and controlling that business is obliterated. The power of regulation can be exercised only by an authority outside of and superior to the corporation to be regulated. State regulation of political corporations is vitiated by the intimate relations between municipal and State politics. There is no compensating gain to cover the loss of the power of regulation.

A municipality has no capital except that which it exacts from private property. The process of obtaining capital in this way is expensive. It is unnecessary, if private capital will take the business and conduct it better than a municipality can, at no greater cost to users. Sound public financiering requires that funds shall not be collected by taxation for a purpose that can be served as well by an investment of private capital under private management. If a municipality borrows money for the purpose of constructing municipal public-service works, it must pay interest for its use. Under the conditions I have named private capital will accept the same rate of interest. No gain can be made on this item.

The difference between the cost of public work, even when erected by contract, and the cost of similar work when done for private account is proverbial. No city is without an illustration. The reason for this is easily found. In the case of public construction, public funds are expended by those who have no interest in the investment, and the investment is made without any idea that the plant constructed must earn a commercial profit as a condition governing its continual operation or the employment of the managers and employees engaged in its operation. The self-interest of those engaged in the work of construction is detached from the work in which they are engaged, causing an inevitable indifference to its best economic execution. No gain can be made in cost of construction.

A municipality permits no competition, pays no incorporation or other taxes of any kind, pays nothing for franchises, and has no limit on its corporate existence, or upon the time during which it shall render the services which it undertakes. It is an untaxed, perpetual, exclusive, and uncontrolled political monopoly. To make comparisons equitable, these conditions must be granted to private corporations, except that of no control. The loss of proper control occurs when municipalities engage in business. What reason is there to suppose that a municipal government would manage the street-car service well, when it cannot well manage the simpler work of street-cleaning? If it is less efficient in management, then its management must result in a loss; and this is the result of every case of municipally-owned and -operated plants for rendering industrial public services, all pretended records to the contrary notwithstanding. The attempt to secure a gain by divorcing the self-interest of the worker from the work he is to do is contrary to the instincts and reason of human nature. It is not in accord with ethical or economic law. It cannot be done.

The paramount consideration to the people of every municipality *is the right to control.* If the control be wisely and justly administered, no sort of ownership, participation in profits, or franchise price can possibly equal the public benefits which are certain to accrue from judicial control.

REDUCING THE COST OF ELECTRIC LIGHT.

By Nelson W. Perry.

IT is so easy to prove on paper by means of apparently legitimate assumptions that the electric light can be made to sell at a considerable profit at a figure which is but a fraction of that usually charged that the public has been easily convinced that a bonanza attended the procurement of an electric-lighting franchise in almost any municipality. The rude awakening to the investor when the annual statement has shown a balance on the wrong side of the ledger, in the face of the brilliant promises held out by lead-pencil prophecies, has too often come as a shock for which there seemed no other explanation so ready as that of wilful misrepresentation and dishonesty. The electric-lighting industry has, therefore, suffered in reputation to such an extent as to make it difficult at the present day to float enterprises even of the most legitimate character. That dishonesty or incompetency has too often been charged where it did not really exist can readily be proved by figures from actual practice which show shortcomings in the performance of machinery that even central-station managers are only now beginning to realize.

A year ago the committee on data of the National Electric Light Association reported data of coal consumption per indicated h. p. in a large number of central stations which attracted wide attention at the time, as indicating poor engineering practice. It was stated that, with a consumption of 1.5 lbs. of coal per indicated horse-power, with a combined engine and dynamo efficiency of 81 per cent., a production of 402.84 watt-hours per lb. of coal would result. This was equivalent to .54 electrical h. p. per lb. of coal, or, in other words, an electrical h. p. could be generated for 1 hour on a consumption of a trifle over 1.8 lbs. of coal. The assumptions on which this statement was based seem entirely legitimate, since engines of a guaranteed efficiency of 90 per cent., and dynamos of an efficiency of 95 per cent. are readily obtained in the market, and it is not unusual to find a combined efficiency, under test conditions, of 85 per cent. These being facts, it was with considerable surprise to many that the results of actual practice were announced. The highest results given were 208 watt-hours per lb. of coal. The next highest was 192, the lowest 25, and the average 91.7 watt-hours, or only 22.7 per cent. of that which was attainable by the best practice. In other words, the average central-station practice required 8 lbs. of coal to produce the same amount of electrical energy that machinery readily attainable was capable of producing on a consumption of 1.8 lbs.

This was a showing so unfavorable to electrical engineering practice as to cause considerable comment in the electrical journals and lead to some question as to the correctness of the figures. An average of data picked up hap-hazard, however, is not to be taken as a fair average of practice, and, since lower averages in efficiencies are to be expected in small stations where the units employed are small than in larger ones where apparatus of the highest refinements and possibilities are the rule, I discarded the reports from all stations consuming less than 10,000 lbs. of coal per 24 hours, and, averaging those above this, found a result of 127.7 watt-hours per lb. of coal, or a consumption of about 5 lbs. of coal per electrical horse-power hour. This was a result which, in ordinary steam practice, would be poor even with small non-condensing engines, and yet undoubtedly most of the engines employed in the works whose results were considered were large compound engines, double or triple expansion and condensing.

At first blush these figures would seem to imply something radically wrong, and it was but natural to turn to foreign practice to see how it compared with ours. Such a reference shows that in the best English central stations the discrepancy between what ought to be and what is is even greater than in this country. Prof. Unwin is authority for the statement that probably the consumption (in England) has in no case been less than 3.3 lbs. of coal, per indicated h. p. This, with the assumed efficiency of 81 per cent. for engine and dynamo, would be equivalent to 4 lbs. of coal per electrical h. p., and reports from several of the large London stations show a consumption of from 6 to 8 or more pounds.

It was some satisfaction to find that American practice was at least no worse than that of our cousins across the water, who pride themselves upon greater refinements in engineering detail than we possess.

This same committee on data had been continued, and during the past year had been engaged in collecting further facts in regard to central-station economy, and their report, which was made at the Cleveland Convention last February, was awaited with considerable interest.

This report embraced data from twenty-four central stations, among which were several of the largest in the country,—seventeen of which exceeded 10,000 lbs. of coal consumption per day. The average consumption of coal for all of those reporting was 127.7 watts per lb. of coal, or 5.8 lbs. of coal per electrical horse-power hour. Taking as before only those stations consuming more than 10,000 lbs. of coal per day, we find the average to be 5.79 lbs. per electrical horse-power hour, which is a better showing for the average of all reporting, but not so good a showing for the average of those stations consuming in excess of 10,000 lbs. of coal per day. A very marked advance was shown, however, in this report in a single instance, which reported a total daily output of nearly 23,000,000 watts per day on a consumption of 87,358 lbs. of coal, which is equivalent to a consumption of a little more than 2.84 lbs. per electrical horse-power hour. This particular station, however, was the only one doing better than 4.1 lbs. of coal per electrical horse-power hour, whereas in one case the consumption was as high as 24.8 lbs., and there were six reporting more than 7 lbs.

These figures are startling, and at once suggest the inquiry as to the cause of these low results. The answer cannot be more completely given than by quoting from some tests made by Prof. Kennedy at the Millbank Street Station of the Westminster Electric Supply Corporation. Dividing the day into three portions, he determined the fuel consumption and the electrical horse-power developed during each period as follows :

TABLE OF COAL CONSUMPTION IN BOILERS WITH VARIABLE LOAD.

	11 A.M to 6 P.M. 7 hrs.	6 P.M. to Midnight 6 hrs.	Midnight to 11 A.M. 11 hrs.
Total I. h.p. hours...	562	1366	407
Total E. h.p. hours................	400	979	260
Coal per I. h.p. hr. lbs............	6.88	3.26	6.26
Coal per El. h.p. hr. lbs...........	9.67	4.55	9.80

This table shows very clearly the effect of light load upon coal consumption on engines of the same class, and, although the best figures given—4.55 lbs. of coal per electrical horse-power hour, while the machinery was operating at its largest load—leave much to be desired, it is shown that even these are doubled during the hours of light load. They show unmistakably that at least one prolific cause of lack of economy in central-station practice is the extremely variable load to which the central lighting station must cater, and, when we consider that even in New York city at least two and a half times as much machinery must be installed as could, if working continuously, produce the same gross output, we see another cause of expense in the way of interest and depreciation charges, which, in the lead-pencil estimates, are apt not to be considered, or at least to be insufficiently provided for.

In fact, that these increased costs due to variable load are not well understood even by those presumed to be fairly well posted was well illustrated by some editorial comments in one of our leading engineering magazines upon some figures given by the author, which assumed the coal consumption per electrical horse-power hour under the conditions of continuous operation at 2.21 lbs., and that under ordinary conditions of practice at 4 lbs., the disparity being characterized as absurd. It seemed to me, therefore, probably not uninteresting to lay the facts before the public, who may not be expected to be so well posted as editors in general are supposed to be.

But, while the item of fuel is an important one in the cost of electrical energy, it is by no means the only one which is seriously affected by the variable character of the central station. I have already referred to its effect upon interest and depreciation charges, and these may in some cases become more important than the fuel charges. It is these that so often render the employment of water powers uneconomical, and which must militate so largely against the economical results from the great Niagara electrical-power scheme. The most noteworthy electrical-power transmission scheme that has thus far been tried was that of the Lauffen experiment in 1891, in which some 300 horse-power were transmitted electrically from the falls of the Neckar at Lauffen to the Frankfort Electrical Exposition grounds,—a distance of 108 miles. Technically this was a great triumph, the efficiency of transmission having been about 75 per cent. Commercially, however, it was a failure, since the power cost, when delivered, five times as much as it could be produced for locally by means of steam. Thus we see how enticing water-power projects often fail commercially, independently of fuel charges or apparatus efficiency, but through exorbitant fixed charges incurred in rendering available what would otherwise prove a cheap source of energy.

There is also a popular misconception as to the relative costs in distribution of energy by different methods. Probably nine out of every ten to whom the question was propounded would answer unhesitatingly that energy for lighting purposes could be delivered more cheaply at a distance by electrical means than by means of gas-transmission, and under some conditions this is true; but I find by calculation that, if the distance involved were a mile, it would require considerably more metal to supply the electric lights by means of the direct current than would be required for pipes to convey a supply of gas for the same number of lights with the same efficiency of transmission.

The bane to the electric-lighting industry is, therefore, the peculiar service which it is required to supply, reaching a very high maximum for a very few hours, and then descending to a very low mean, during which time the apparatus has but small earning capacity, and that portion which is not lying totally idle is producing energy at an uneconomical rate.

Could the central-station apparatus be kept in operation continuously at its most efficient output, the electric light could be sold to consumers at a considerable discount upon the price of gas, and still net the manufacturer a larger profit than the gas-man realizes, and this without any change in apparatus or methods of distribution from those now in vogue.

The gas manufacturer, though he have exactly the same service to meet as the central-station manager, is not handicapped by the irregularity of this service, in that he can store up the product which he has to sell, when the product is greater than the demand, and draw upon this store during the hours when the demand exceeds the supply. He need only supply sufficient apparatus to meet the average demand, and this, being kept in continual operation at its most efficient rate, earns to its fullest extent for every hour in the day. The central-station manager, on the other hand, has no method of storing up the product which he has to sell. If he employ storage of any kind at any stage of the manufacture, it introduces additional transformations of energy which not only are apt to be expensive in themselves, but also involve necessary losses in final output which must be balanced against any economies which they may present.

It is natural, therefore, that relief should be sought rather in increasing the regularity of the demand than in these methods of storage; but here, too, difficulties present themselves which have not as yet been obviated. In the first place, if a day-load should be acquired, it would tend to overlap the maximum lighting load which in winter time comes on before six o'clock, and on dark days may be an hour or two earlier. The result would be that the double load which at most would last but two hours, and which in the summer time would not exist at all, would have to be provided for by machinery which would be idle the rest of the day. It is clear, therefore, that this change would not better matters much.

What promises to be a better method is one that has been tried on a small scale abroad, but not yet, to any extent, in this country,—*viz.*: encouraging the use of current during the hours of light load by reducing the price of service during those hours. The central-station manager could well afford to reduce his price to a mere fraction of what he now charges, if by that means he could obtain a steady demand for his product throughout the 24 hours.

Mr. H. Ward Leonard, who has given this subject more study perhaps than anyone else in this country, said in a paper recently read before the American Institute of Electrical Engineers: "If central-station companies would offer such a discount due to load factor as to warrant their individual customers in installing at their own expense a storage plant which they could charge at the minimum rate per kilowatt-hour, and then use this stored energy to supply their occasional demands, I believe it is possible that the central-station companies, the storage-battery companies, and the consumers might all derive a profit from the arrangement. I have no doubt that a central-station company could afford to make a rate of four cents per kilowatt-hour for a continuous service night and day, and make a satisfactory profit, while it would surely lose money in supplying an elevator at fifteen cents per kilowatt hour." If electrical energy were supplied to a customer at the lower figure, it would mean electric light at about ⅙ cent an hour instead of 1 cent as now charged, or ¾ cent for gaslight, where gas costs $1.50 per thousand cu. ft.

In this connection he gives the following schedule of rates, which he thinks should be charged per kilowatt-hour to customers, according to the proportion of the 24 hours they use current, together with the resultant gross income that these charges would bring into the central station:

Load Factor.	Rate per kw. hour in cents.	Resultant gross income per annum per kw. of plant.
5	30	$131.40
10	20	175.20
15	16	210.24
20	13	227.76
25	11.2	245.28
30	10	262.80
35	9.2	281.07
40	8.5	297.84
50	7	306.60
60	6	315.36
70	5.3	325.00
80	4.8	336.38
90	4.4	346.89
100	4	350.40

It will be noticed that, although, when the customer uses current but 5 per cent. of the time (which is better than the average of electric-light consumers), he is charged seven and a half times as much per kilowatt-hour as when using it continuously, the gross income to the central station is only about one-third what it is from the lower figure. Or, in other words, the central-station company would, according to these figures, get a gross return nearly three times as great by selling its current to a customer who would take it constantly at a rate of ⅙ cent per lamp per hour than it would get from the customer who used his light but 1½ hours per day, and who paid it at the rate of 1¼ cents per lamp per hour.

Doubtless some such arrangement as here suggested will in time be resorted to in this country to the advantage both of the consumer and the manufacturer.

Then there is another method by which relief may be obtained,—*viz.*, by finding some by-product for the central station man to manufacture during the hours of light load. I use the term "by-product" advisedly, for it must be something whose manufacture may be stopped the moment the machinery is required for the main business. The manufacture of ice is one such "by-product" that has found some favor among central-station men; but, while this may give employment to boilers and engines during the day-time in summer, the dynamos are lying idle even during the few months when there is a demand for ice, and during the winter months such a plan would afford no relief whatever. It would be far preferable if some electrical product could be found, for this would give employment to all of the machinery at all times of the year when not otherwise required. This, in fact, is the invention which is most required at the present day, and seems more possible of attainment than any other form of relief thus far suggested.

One of the recent products of the electrical furnace that looks promising for this purpose is calcium carbid,—a product not new to chemistry, but new to commerce. This substance, which is produced by the fusion of lime and coal-dust in the electric arc, when decomposed by the simple addition of water, gives rise to acetylene gas,—one of the most highly luminous gases known, as well as possessing the highest calorific powers of any of the hydro-carbon gases. We, on this side of the Atlantic, have been rather skeptical as to the advisability or practicability of undertaking the manufacture of calcium carbid, but the proposition has been given a standing which at least makes it worthy of consideration by our continental friends, who are about to undertake it. It seems that a company has actually been formed in Germany for this purpose, known as the "Gesellschaft zur Verwerthung von Acetylen-gas." That this is no mere hap-hazard, ill-digested concern is evidenced by the fact that the great German electrical concern of Siemens & Halske has taken a substantial interest in the project. Should the undertaking prove a commercial one, it will be of the utmost import to the central-station man, and the outcome will be awaited with the greatest interest.

The commercial status of the manufacture remains, however, to be proved. There are two other products, however,—already objects of commercial manufacture,—whose status is already determined. One of these is aluminum, and the other carborundum. These articles are already being manufactured on a large scale, and their manufacturers are seeking cheaper power at Niagara to enable them to increase their outputs at lower figures. The question arises: would it not pay the central-station man to manufacture these products during the hours of light load, at a figure with which even the cheap water-powers at Niagara could not compete, if by this means he could keep all his apparatus occupied at its best rate throughout the twenty-four hours, and thereby reduce the cost of his electric light by from 50 to 75 per cent?

As indicating the cost of power in ordinary practice when it is produced in a fairly continuous manner, I may cite the case of the Chelsea Jute Mills of Brooklyn, which, during a period of six days, while developing an average of 653.3 indicated h. p., consumed but 1.482 lbs. of coal per indicated h. p. per hour. This is equivalent, if we assume a combined engine and dynamo efficiency of 81 per cent., to a consumption of 1.83 lbs. per electrical h. p. hour.

During this time the load was by no means constant, but varied between 495.21 and 764.96 h. p. The equipment consisted of Corliss compound condensing engines and vertical tubular boilers, and was in operation 10 hours each day. The figures given cover the whole amount of fuel used, including banking, etc. Most of our modern electric-lighting stations have quite as good an equipment as this, and yet statistics show that the best of them average 7 to 8 lbs. of coal.

The demand of the day therefore is *not* better dynamos, better engines, better boilers, or better methods of transmission, but steadier jobs for the apparatus we have, and he who will invent that job will do a better service to the electrical industry than he who invents a new electrical system.

ECONOMIC POSSIBILITIES OF THE MILLING MACHINE.

By Horace L. Arnold.

NOTHING is more surprising than the extreme reluctance with which the human mind accepts ultimate results; the more obvious the result, the more infallibly certain the present coming of this result, the more doubtful we are of its occurrence. Granted that two and two exist, we are very slow to admit that their sum may possibly reach the incredible aggregate of four, and to assert that such is surely the case savors of a radical and hazardous temerity which no soundly conservative engineering intellect can tolerate. We can admit the existence of the stepping-stones; we can even assert that they are firmly supported in the stream of current practice within easy stride of each other; but the stream still flows and eddies noisily about these yet unsanctioned novelties of but few years' duration, and bold indeed is the engineer who dares set his feet upon them with the firm intention of crossing this consecrated tide of current practice, no matter how desirable or easily gained the farther shore may appear.

The one problem of the machine shop is to remove that part of pieces of metal which makes the rough casting or forging differ from the finished work. How to quickest cut away what we do not want, and be sure to leave what we do want, of a given mass of metal is the constant question of the engine and machine builder. We know that we must use tools to shape metal; our fingers and teeth are not equal to the task. The hammer, first of tools, and fully accepted as legitimate, is the first resort; the chisel is next brought into action; the two are boldly combined in operation, and slowly but surely the outline of the piece of metal is brought to the drawing. Should the work be too slow, two hammers and two chisels in the hands of two workmen may be used; and, if the construction still lags, more hammers, more chisels, and more men may be put upon the work so long as room can be had for effective action on the piece. Not so very long ago the hammer and chisel, supplemented by the file, were the only tools by which the metal-worker could produce flat surfaces on pieces too large to be swung on the face plate of the lathe. Then the chisel was put in a metal hand or holder; the tool-holder was guided to travel in straight lines and pushed over the work, cutting portions of the metal away as it traveled; and two tools, three tools, and even four and five planing tools, each held in a head of its own, were made to work the same piece of metal at the same time. Long before the day of the planer the mill was known in the finely-toothed form but little removed from the file. In the file we had a multitude of teeth combined, each tearing off its small particle of the metal surface over which the file was pushed. From the flat file in the hand to the disc file in the foot-lathe was not, seemingly, a very long step, and it was made no one knows when,—probably thousands of years ago. It speaks well for our respect for tradition and established practice that we still keep the mill in its old place of a revolving file, useful to slowly remove little chips from metal, and that the very best and most advanced of modern toolmakers do not yet admit that it is very soon to be the almost exclusive agent in all metal-surfacing operations. Yet such is certainly the case, and as surely as two and two make four, just so surely will we soon look back on our present use of the planer in all large metal-surfacing operations with the same complacent pity which soothes our vanity as we picture the early machinist chipping his meager "spots" and "fitting strips" laboriously into the line of his straight edge and level.

With the hammer and chisel the time limit of production is fixed by the number of chisels which can be brought into effective use; with the planer the time limit is fixed by the number of tools which can be brought into position to cut the work at the same time; very rarely over five; so rarely that not a single case can be recalled in which more than five planer-tools have been seen by the writer in simultaneous action upon the same piece; commonly but one.

But by the use of the mill a great number of cutting edges may be brought into simultaneous action on pieces of limited extent.

Can we, then, by the use of this indefinitely multi-toothed tool, indefinitely decrease the time limit of metal-surfacing?

The engineering talent of the whole machine world by its practice answers this question in the negative, and sticks to the single- or double-tooled planer with that fine conservative respect for established practice which distinguishes sound engineering from the crazy ventures of the inventor, whose very name is a reproach.

In the case of the hammer and chisel and the diamond point in the planer-tool post, one and one make two, and two and two make four, but the reputable engineer does not admit so bold an assertion when applied to the teeth or cutting tools of mills.

Yet there are constantly increasing examples of mill practice which show that output may increase with the number of cutting tools in simultaneous action, just as surely and infallibly in the case of mill teeth as in the case of chisels and hammers, or diamond points in planer-tool posts. There are cases where cast iron has been surfaced on the milling machine forty times as fast as the same pieces were surfaced on good planers. Brown and Sharpe have cut a 60-tooth, 6-in. face gear, 3 diametral pitch, inside of 30 minutes, feeding at the rate of about 18 in. per minute. Brooks has built a milling machine which can finish one side and two edges of a piece 20 ft. long × 100″ wide × 20″ deep, at one operation. Ingersoll has operated one of his mills in one of his milling machines for eight hours with a feed of over ¼″ per tooth on cast iron. With the Brown and Sharpe feed of 18″ per minute on the Brooks machine a piece of cast iron 20 ft. long, 8 ft. and 4 in. wide, and 20 in. thick could be surfaced on one side and two edges inside of half an hour, at a total cost, including everything, of less than one dollar.

Yet not even milling-machine builders dare to admit that such astounding cheapness of metal-surfacing can be had. The facts are beyond dispute, but two and two cannot yet be admitted to make four on the milling machine. The stepping stones are firmly placed, but no engineer dares risk a tumble and splash before the public eye by walking on them.

All engineers are perfectly ready to admit that in the production of small interchangeable parts the milling machine is indispensable, but not one can be found to say that the day of the planer has passed.

The milling machine can make the rifle, the sewing machine, the type-writer, and even the engine lathe bed, but it cannot make the steam engine, the locomotive frame, or any general machine work of magnitude.

What are the causes of this profound distrust of a machine which promises to reduce the cost of metal-surfacing to say one-tenth of the best that can be done with planers?

The limits assigned to this article are not sufficient to contain a fully-detailed answer to this question, and to fortify such answer with full proof of its correctness. There are two forms of mill cut by which mill teeth act upon metal. The first is that of side-cutting mills, in which the teeth act precisely as the paddles of a side-wheel steamer act on the water, and the other the end-cutting mill, in which the mill teeth act exactly as a plow turns a furrow in earth; generally speaking, the paddle-wheel cut requires vastly more power to remove a given section of cast iron than is needed by the plowshare cut, and, to produce their best effects, both forms of mill cut require very great powers of resistance in the milling-machine framing. The form and angles of the teeth of the two principal varieties of mills make enormous variations in the power required to remove a given section of metal by their action; and the resistance of the paddle-wheel form to the feed motion may be varied, by the direction of mill rotation, from a feed-table resistance, which is overcome with difficulty by the most powerful feed action which the machine can contain, to a very powerful self-feeding impulse, which the feed-action merely regulates by a let-off function. The angles of the plowshare tooth may be such as to either put an enormous thrust on the mill carrying spindle journals, or to relieve the mill spindle of all except rotative or torsional strains. Precisely as a diamond point lathe tool may be so ground and set in the tool post of an engine lathe that the chip cut will force the tool into the metal and cause the tool carriage to have a regular advance, although the carriage feed mechanism is thrown entirely out of action, the mill cut chip may be made to so balance the mill tooth resistances that the spindle driving the plowshare form of mill tooth has actually no side thrust to resist, and no end thrust away from the work. So far as the mill tooth, and the action of the mill tooth on the metal, and the action of the chip cut on the mill tooth are concerned, it is true that there is no radical difficulty existing of any sort to prevent the simultaneous use of all the mill teeth which can be brought to bear on a given work surface; and each tooth may cut a chip as thick as the single planer tool of equal strength can remove from the same metal; and it need take no more power to drive a single mill tooth than is required to drive a shaper ram carried tool making the same cut, which is almost invariably greatly less than is demanded for an equal cut made on the planer. This assertion that a mill making a cut say 24″ wide in grey iron requires no more power than would be needed to drive a planer table carrying the same piece acted on to the same depth by a sufficient number of diamond points or other roughing tools, to cover the entire surface at one cut at the linear feed speed of the milling machine table, will meet with instant denial from some engineers of experience: it must, however, be given here as an unsupported assertion, although the writer is certain of its truth. Many experimenters with milling cuts have failed to discover the most important facts of the mill tooth shape problem, and the paddle-wheel action is almost always investigated in preference to the plowshare action, which will very soon be recognized as the better form, and also the form which lends itself most readily to the production of section contours demanded by the machine constructor. Passing all of these points, each of which might rightly take more space than this entire paper, a very brief consideration of the chief types of milling machines must be had. These types are three in number: (1) the "Lincoln," or ordinary manufacturing milling machine, of which Pratt and Whitney alone have built considerably more than five thousand: (2) the pillar and knee form, most widely known in the Brown and Sharpe "Index" milling machine, to be found in every tool room of every machine shop in the world of any pretensions, and adhered to by Brown and Sharpe in their larger machines for finishing cast-iron surfaces; (3) the planer form, adopted by Brooks in his unique example, and by Ingersoll as a regular line of manufacture.

Types one and three are framed to give the mill carrying spindle support on both sides of the mill; type two is not framed with that view in the construction of its principal members, and the out board mill spindle support of type two is of the afterthought description, and, although effective for a range of cuts fully up to present practice, does not present such original structural facilities for mill support as do the "Lincoln" and "Planer" framed milling machines. All three of these types of machine are adapted to use both the paddle-wheel and plowshare action mills, although Brooks does use the plowshare (end mill) form only. Pratt and Whitney, Brown and Sharpe, and Ingersoll use either form of mill indifferently, Ingersoll perhaps fully equalling either of the others in design so far as efficient mill support is concerned.

The problem of the milling machine frame is really this: given full elements of planing machines which long practice has proved equal to the support of say three or five cutting tools covering say a finished surface of $\frac{3}{4}''$ or $1\frac{1}{4}'' \times 15$ or 20 ft. per minute, it is required to find the elements of the milling machine construction, which shall drive and support a sufficient number of cutting tools to cover in one case the greatest width of piece the machine will take through between its mill arbor supports, or, in the case of the Brooks machine, two very considerable side cuts in addition to the full width top cut. The designer at once discovers from the very insignificant power delivered to the planer by its narrow slow belt or very narrow quick belt that he has but few horse powers of effect to resist; he frames and powers his machine in excess of the planer practice, and he produces a tool which is actually capable of doing from six to forty times the work of the single tool planer commonly employed upon pieces of the same class. Clearly the planer might be the more effective tool of the two, as the planer tools might be set closer together, and hence be more numerous than the mill teeth. Suppose a 24-in. planer table to have bolted to it a piece of grey iron 24 in. wide; suppose this planer can carry a $\frac{1}{16}$-in. feed on the depth of cut needed to finish the work; now suppose that, instead of one cutting tool in one tool post, we put in 384 tools ($24 \times 16 = 384$),—there is then no physical impossibility to prevent surfacing this 24″ wide piece at one single traverse of the planer table, and a piece 24″ wide × 20 ft. long could thus be finished in one minute at a total cost of say 5 cents, as against an expense of say $3.00, entailed by the 540 minutes needed to surface this piece by usual planer practice with $\frac{1}{16}$-in. feed of a single diamond-point tool. The common method would be, were a constant output of such surfaces demanded, to employ a great number of planers, attended by as few hands as possible, and so decrease the labor cost as much as possible. But the single tool planer is not only slow; it is also bulky and costly, and the room and price needed for planer effect compare most unfavorably with the space and cost needed to put an equal number of milling-machine cutting tools in operation on the work which the planers can finish. But the machine tool engineers, as stated at the outset, will not admit the tool for tool comparison between planers and milling machines.

Twenty to twenty-five feet surface speed is about the outside limit for grey-iron planer cuts; this might often be more, and grey iron is milled regularly with cutting edge speeds of 30, 40, 50, and even as high as 60 ft. per minute without harm to anything. Thirty feet is so common that it can be safely assumed as normal. A mill surface travel of 30 feet per minute carries 360 inch pitched mill teeth past a fixed point every minute. Ingersoll, during eight consecutive hours, made each mill tooth cover over $\frac{1}{4}''$. Taking one-fourth of this effect as a safe basis, the wide tooth space of 1 in. would give as above $\frac{360}{16} =$ 22 in. feed per minute, as possible with an inch pitch mill tooth and thirty feet surface speed. A per tooth feed $\frac{1}{10}''$ has been successfully used at a surface speed which gave 40″ of linear surface cut per minute. The 5-tool planer can cover (as before) at $\frac{1}{16}''$ feed less than $\frac{5}{8}$ of a sq. ft. of finished surface of grey iron per minute. The milling machine, surfacing a piece 24″ wide, would, at a feed of 22″ per minute, produce $3\frac{2}{3}$ sq. ft. per minute, which makes the effect of the milling-machine to the effect of the planer as 15 is to 88, or nearly 6 to 1. Hence the milling machine might require 6 times the power needed for the planer, even when the planer is using 5 tools, and might be held also to demand 6 times as much frame support for the mill as good practice would give the planer tools. In point of fact, the milling machines are belted (powered) far above the planers, as indeed they must be to drive them at all, while they are not in any case framed more heavily than heavy planers, and in most examples the mill arbor is not so well supported as are the planer tool saddles on the heavy planer cross rails. Ingersoll, adopting the planer type and using a massive cross rail, and Brooks, under precisely the same conditions, give an approach to efficient mill support. Builders of the "Phœnix" and pillar and knee types give much less mill support than Ingersoll and Brooks give, and also give not more than one-tenth the support which the planer tool has in the severest common practice. One and one do not make two, nor do two and two make four, when the machine-tool designer considers the milling-machine frame stability needed to give resistances equal to those put behind the planer tool. Hence Ingersoll gives a maximum feed of 5″ only in his milling machines, while the Pratt and Whitney, Brown and Sharpe, and Newton practice seldom exceeds 1¾″ at work, and commonly falls below that meager figure. It is true that at the feeds used the milling machine shows a startling economy; it is also true that insufficient framing is the first factor in the current belief that each mill tooth cannot take so great a chip as each planer tool, or, in other words, that two and two do not make four when considered as elements of milling-machine work production.

There also exists an entirely unfounded engineering belief that the production of milling cutters must be much more costly than the production of planer tools to cut away a given weight of cast-iron chips. This is an entire mistake. A large, finely-finished solid steel mill is one of the expensive productions of the tool maker's art, but it represents the life of many hundreds of the comparatively cheap planer tools; and especially in the Ingersoll form, and in other inserted tooth forms, the mill is by far the cheaper of the two when possible life-long effect is considered.

Again, there is the belief, founded in ignorance pure and simple, that very expensive and delicately-adjusted assemblages of mills, or "gangs," are needed to produce given outlines of finished work section. The E. W. Bliss Company have been for 20 years producing great numbers of milled press frames, finished by mills which are in no way special, and in no case, in their general work, does the Bliss company use gang mills, as their milling machines are of the slotting machine type, with single spindles, and incapable of using gang mills.

The truth is that by means of simple and perfectly obvious combinations, which are not yet, however, in general use, a few plain small mills may be made to produce milled surfaces of any contour of section which can be bounded by right lines; not, indeed, at one single cut, but at two or three cuts, perhaps, or possibly even more; these cuts being of such width, and made at so rapid a pace, that the work is finished with stock tools, adapted to a host of different jobs, at an average cost not exceeding one-twentieth part of planing prices.

The situation at the present time is exactly this; the milling machine has invaded each of the grand divisions of the old-time engineer's work, and, whether applied to planing, boring, turning, slotting, or vise work, it has in every instance divided the cost of production by a surprising factor. The quality of the work has been in every case improved, and the grade of labor required to produce that work has in every case been lowered. Yet the conservative engineer denies that the milling-machine can ever be more than a special adjunct to the regular machine shop plant, and refuses to recognize it as a factor in general production. Rapid production is admitted, since so much cannot be denied, but accuracy of surface-produced in work of considerable size is still questioned by engineers at large. Bliss produces press frames up to the capacity of his largest machines; Pratt and Whitney mill their lathe beds, V-s and all, with better results than planing ever gave in their shops where accurate planer hands abound. The writer has within a very short time examined steel pieces $10'' \times 1\frac{3}{4}'' \times \frac{1}{4}''$, in which the error limit was less than $\frac{1}{4000}''$ as they came from the milling machine; they were finished at a cost which cannot be given, but is incredibly low when the error limit is considered.

Nothing in the whole round of human affairs is more certain than that the buyer will seek the lowest cost for his purchase. However long and however blindly established practice may be followed, a day finally comes when the most conservative tradesman opens his eyes to the fact that others in his own line are buying finished product at lower prices than his own cost-book shows, and he awakes to the situation.

The time is very near at hand when the milling machine, with its multiple-toothed cutter, will take the place in the general engineer's plant which it has already won in thousands of special instances; large surfaces will be submitted to its action; engine cylinders and frames will be finished wholly by the multiple-tooth cutter, as they are even now in part in many shops; we shall see large structures finished at two passages of the milling-machine table at a total rate of 12 or 15 in. of length per minute, regardless of section, all surfaces, however relatively located, being simultaneously operated upon; and a new factor in machine production will be established, which will effect a greater reduction in cost and improvement in product than that wrought by the general introduction of the planer sixty years ago.

RECENT ARCHITECTURE IN FRANCE.

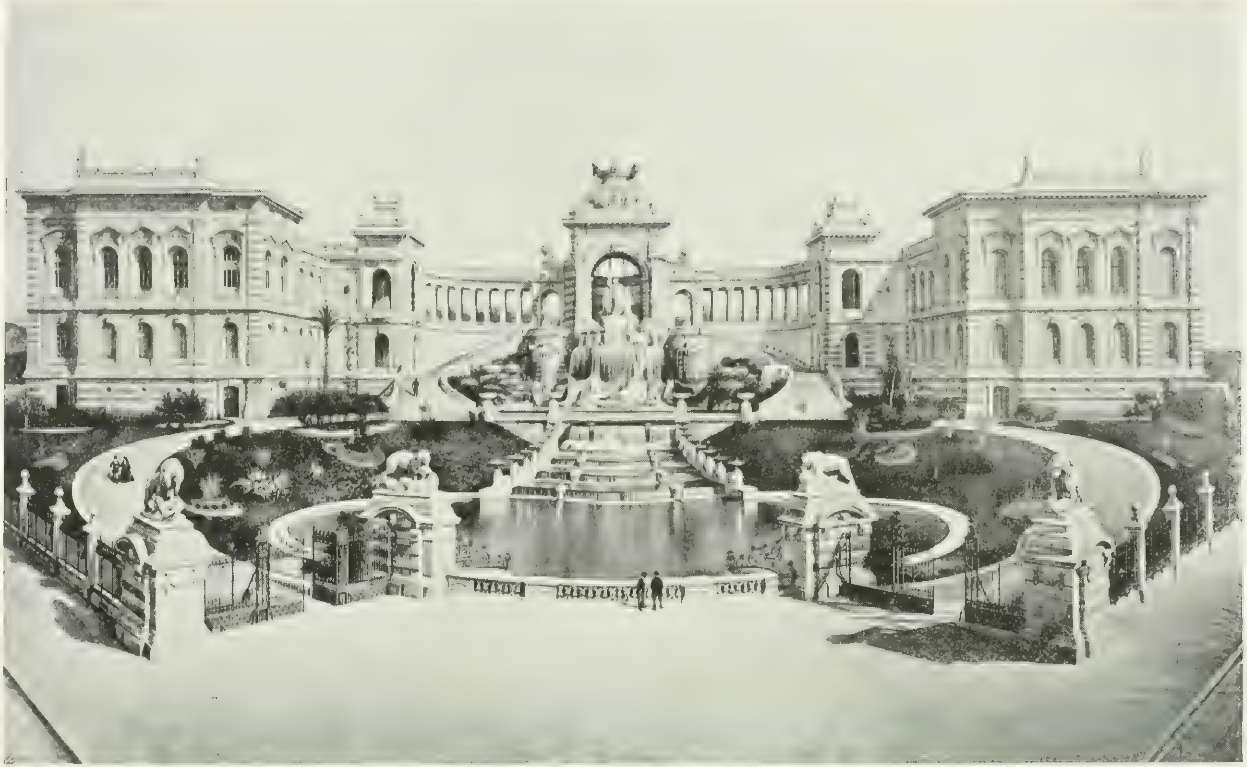
(SECOND PAPER.)

By Barr Ferree.

> And Abraham drew near, and said, Wilt thou also destroy the righteous with the wicked? Peradventure there be fifty righteous within the city. . . . And the Lord said, If I find fifty righteous within the city, then I will spare all the place for their sakes. And Abraham answered and said. . . . Peradventure there shall lack five of the fifty righteous, wilt thou destroy all the city for lack of five? And he said, If I find there forty and five, I will not destroy it. . . . And he said, Oh, let not the Lord be angry, and I will yet speak but this once: Peradventure ten shall be found there. And he said, I will not destroy it for ten's sake.—GENESIS: xviii: 23-33.

THREE departmental cities stand out among the innumerable cities and towns in France as special centres of modern architectural interest. Marseilles, Montpellier, and Bordeaux are the three cities in which the most interesting of recent building is to be seen and in the greatest quantity. Other cities are not wanting in modern buildings. Grenoble contains a square entirely surrounded by recent important buildings, and it is interesting as one of the few large squares in France so surrounded. Toulouse has a few modern buildings, though none of importance. Toulon is better representative in this respect. Tours, Lille, and Poitiers have some important buildings; but, with these exceptions, and those of the three cities first named, there are not many French cities that can boast more than one or two important buildings. The larger part of their buildings are either old, and therefore have an interest quite different from that which belongs to new structures, or else so utterly featureless as to be devoid of architectural value apart from their planning and arrangement.

In Marseilles the pilgrim to modern architectural shrines will find a good deal to demand his attention. The main street of the city is a mimic Paris street, with huge hotels hidden behind solemn exteriors, whose forms have the familiar, homelike aspect that one finds in most French cities. In the Palais de Longchamps and the new cathedral the student will find two noble works of the first order,—the one representative of secular art, the other a type of the latest French effort in religious art. The Palais de Longchamps is one of those elaborate compositions that illustrate both the faults and the strength of modern French architecture. It is a superb conception, situated on rising ground at the top of a long street, beautifully shaded with trees.

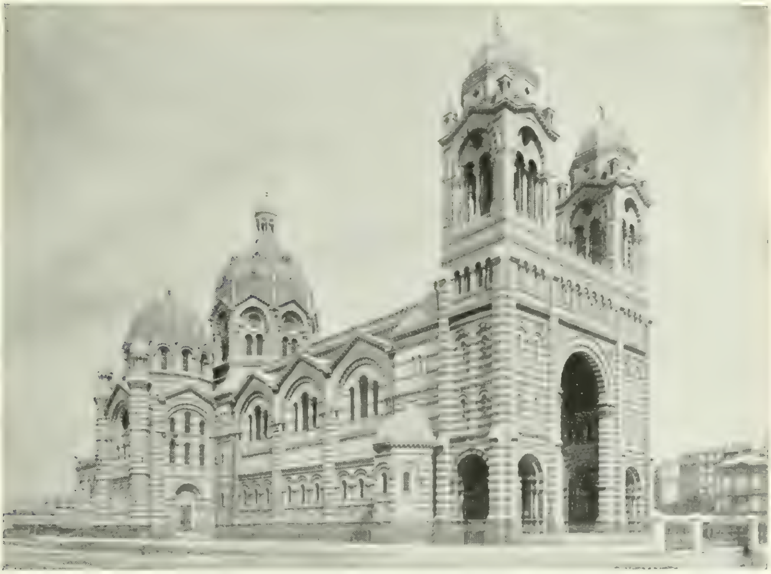


PALAIS DE LONGCHAMPS, MUSÉE DES BEAUX ARTS, MARSEILLES.

M. Espérandieu, Architect.

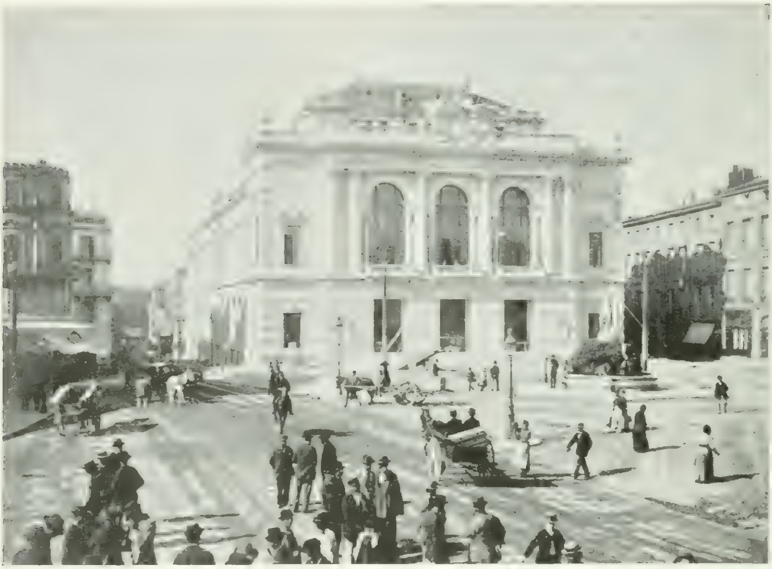
The situation is, indeed, ideal, and the architect has made the most of it. In truth, the plan is the better part; the arrangement of the terraces, the sweep of the steps, the fall of the fountains, and the enclosing of the whole with an architectural background that is at once the center and culmination of the design are magnificently planned. The chief defect is in the palaces or the museums themselves, which, while pretentious enough, are not worked out with sufficient care, and are deficient in detail,—that fatal error of almost all French building.

The new cathedral of Marseilles is interesting because it offers so great a contrast to much contemporary ecclesiastical French architecture. Before visiting Marseilles, I had made a pilgrimage to the church of Notre Dame de Fourvière on the hill above Lyons, which, so far as my knowledge goes, is clearly the worst church in the whole world. The basilica of Notre Dame de la Garde, on the heights of Marseilles, is another structure that might be classed with Notre Dame de Fourvière, but it is distinctly superior to it. At Fourvière all the evils of modern French taste are in full blast. The architect has apparently invented everything out of his head; certainly such forms, such combinations, such sculpture, such detail, such color, exist nowhere else on the face of the earth. The crypt is bad enough, and the



THE CATHEDRAL, MARSEILLES.

MM. Vaudoyer, Espérandieu & Révoil, Architects.



THÉÂTRE, MONTPELLIER.

finished bay, with all its horror of completed detail, the worst of all; but the upper chapel—or basilica, as it is properly called—is the most intolerable room it has been my misfortune to see. Everything that is bad is here, everything that is offensive to taste and art; everything that an architect should not do has been done in this building. And there has been no stint of money; the materials are of the richest, the decorations the most elaborate; yet in the very centre of this horrible unfinished, costly, extravagant hall is an alms-box, that visitors may, by their gifts there deposited, help on the horrid work! Those gentlemen who, in America, wish for a "modern" church architecture will do well to visit Notre Dame de Fourvière before uttering further fulminations on that subject; there they will learn, if they have not before grasped the truth, of the logical outcome of "modern" ideas in church building.

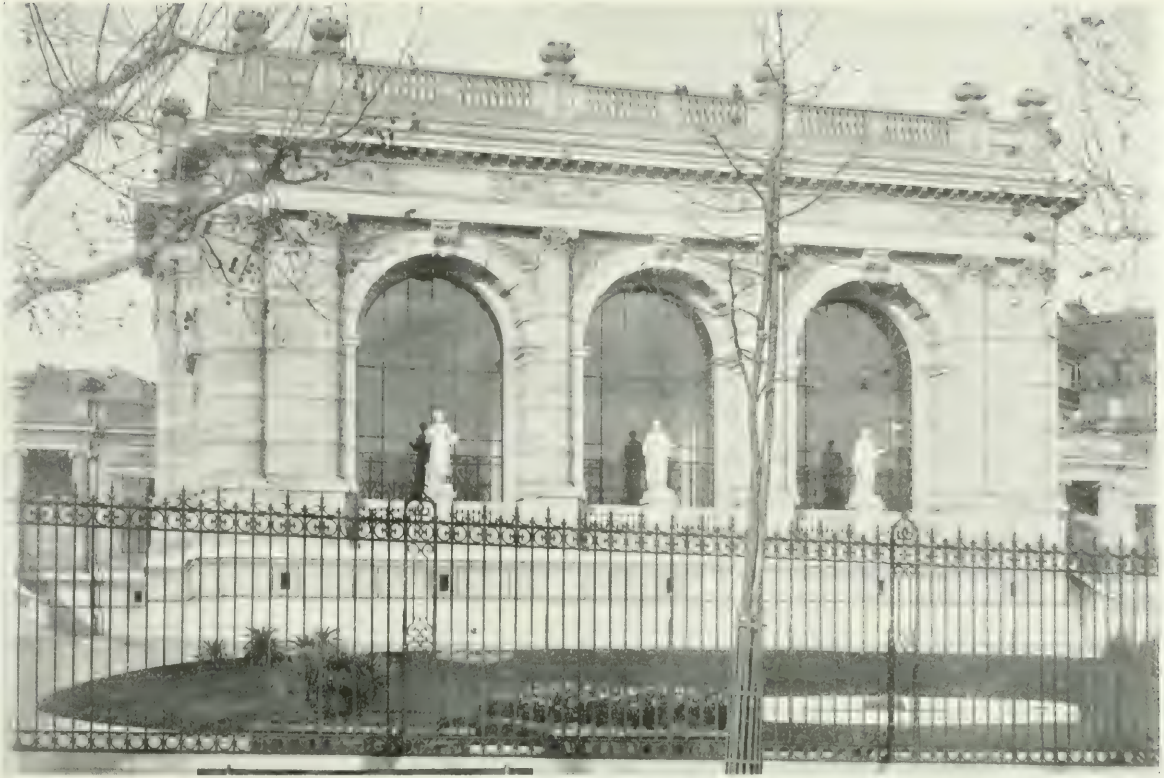
There is nothing of this in the cathedral of Marseilles, which is more impressive within than without, and best seen outwardly towards the east end, where the Lady Chapel stretches away to an appalling length behind the west towers. It is a church of enormous size; and not only is it big, but it seems big,—an impression which the greatest church of the Renaissance does not succeed in giving. The style is not a happy one; it is neither Romanesque nor Byzantine, yet it suggests both. But the interior is grand and imposing; the choir is of aston-

MUSÉE FABRE, MONTPELLIER.

ishing length, with rich architectural perspective; and in the over-powering interior the architect has obtained a result that almost compensates for the unpleasant features of his exterior. It is not an impression one expects from the outside of this church, but of its type it is the most successful church in France. The church of Montmartre at Paris, with which it may best be compared, does not approach it in grandness of effect. This last church, by the way, is a sad illustration of the manner in which the French can entirely throw away an opportunity when they feel disposed to do so.

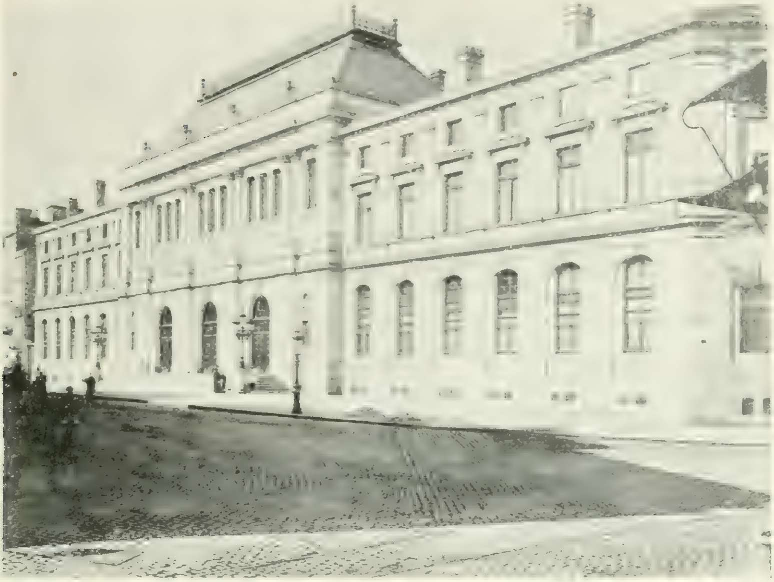
Montpellier I visited with special interest. I had been told by an eminent Frenchite at home that it was "fine," and I earnestly hoped I would think so too. My preliminary drive around the city told me why he thought it was fine, and told me as well that the fineness was of a sort I could not myself appreciate. Of all the French cities I have visited Montpellier is the newest and the most up-to-date. The student of modern architecture will here find no single masterpiece that will

PRÉFECTURE, MONTPELLIER.



MUSÉE GALLIARA, PARIS.

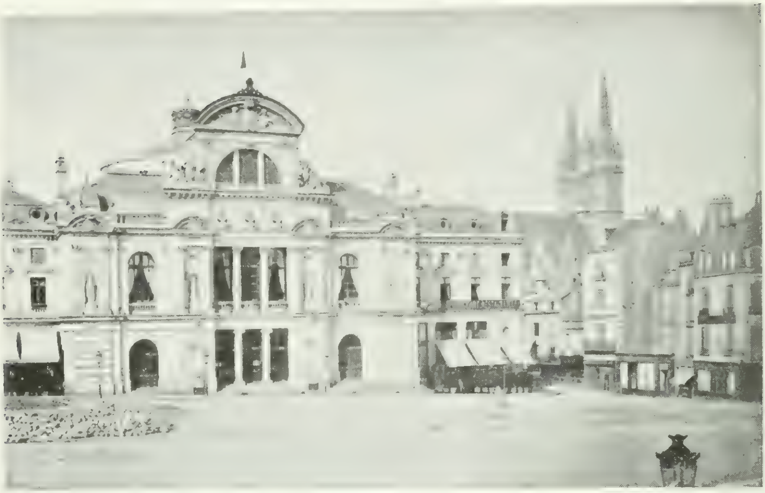
M. Ginain, Architect.



FACULTÉ DES LETTRES ET DES SCIENCES, BORDEAUX.
M. Durand, Architect.

compare with the great buildings of Paris, Marseilles, or Bordeaux, but in very much less space than in any of those cities he will be able to study his art in many very good examples. The Théâtre, which has but just been finished, is a quiet and stately design, entirely devoid of eccentricities; the Musée, the Préfecture, the Palais du Justice are all in the same quiet, good taste; and, above all,—I presume this is the proper gradation,—the streets are lined with shops and dwellings of the most approved Parisian type. Could anything be more delightful? And verily the town is a gem in its way, and illustrates just what the modern French architect can do when he has a reasonable amount of money to spend and a tolerable opportunity to utilize his talent for design. By the time I reached Montpellier I had visited nearly fifty cities in France, and everything seemed so delightfully homelike and familiar! Whatever French architecture does, it at least prevents the traveller from feeling a stranger and alone in distant cities. When one can tell beforehand how the buildings that he is about to see will look, a great deal of saving is effected in the nervous system; one is not liable to the shock of new ideas and strange sights.

If Montpellier is "fine" to see from the Frenchite standpoint, Bordeaux is certainly magnificent. Here is scarcely an arch that is not round; scarcely a window that is not encased in a frame of its own;

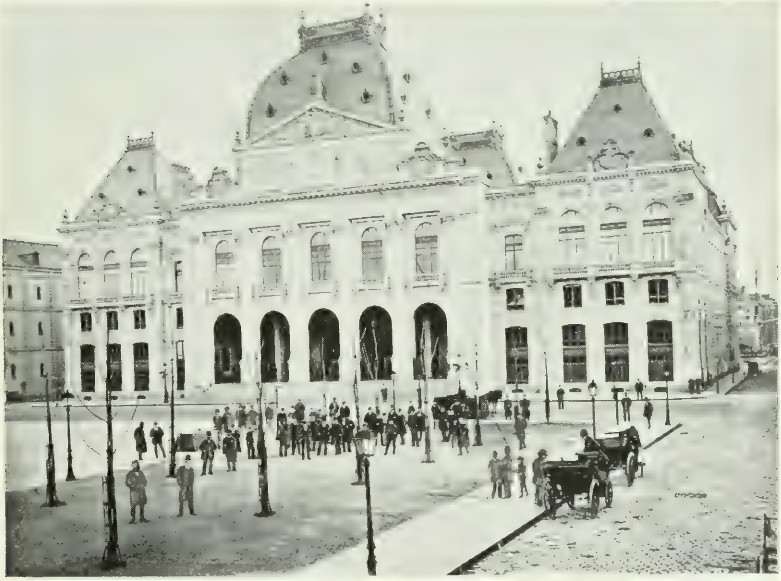


THÉÂTRE, ANGERS.
M. Magne, Architect.

hardly a floor that is not marked off by balconies on corbels or brackets of the most approved type ; hardly a window without its grille ; scarce a façade without its pilasters ; in fine, not to exaggerate, and barring some ecclesiastical edifices, scarcely a structure that does not, in some shape or other, in some form, detail, or general design indicate the sacred and penetrating influence of the School manner. I would not say that Bordeaux is the best city in which to study the consecrated influences of that cult, but here at least it may be studied in multitudinous —if not always happy and successful—results, though not always in the latest and most approved style.

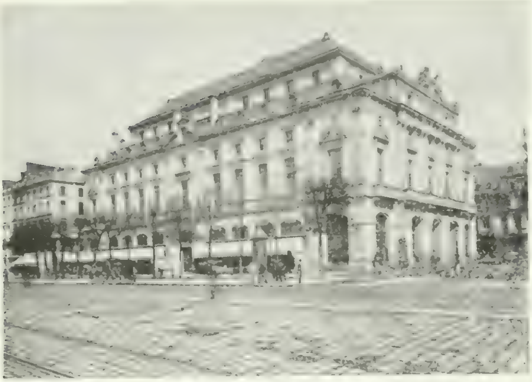
Perhaps the most notable single modern building in Bordeaux is that of the Faculté des Lettres et des Sciences. This is a large and spacious structure, the main front consisting of a well-designed and admirably-accentuated central pavilion, and two long wings treated with considerable severity. The central pavilion is a very well-thought-out piece of work, but the wings, with their insufficient detail and their shallow pilasters, are excellent types of that poverty of resource noticeable in so much new building. The most conspicuous error in the design is in the basement windows, where, after providing large and ample arched openings, the architect has filled them in at the side, apparently because his window-frames did not fit. In the centre of the adjoining lateral façade is a group of basement windows, in which the sash fills the whole space allotted to it by the stone construction ; and the contrast between these windows and the pieced-out ones is very striking.

Nearly every French city contains four buildings of more or less monumental interest,—the Hötel de Ville, the Palais de Justice, the Théâtre, and, if it be the chief city of a department, the Préfecture. So persistently have the problems presented in these four structures been solved by French architects that well-defined types of each of them have been evolved. The Hôtel de Ville has a central pavilion, a tower in the middle, two projecting wings, and a high roof. The Palais de Justice, in its latest form, surrounds an open court, and is usually entered through a stately portico. The Préfecture, being a residence, offers greater variety, and has not yet been reduced to as definite a type as the others of the group. The Théâtre has, to some extent, been influenced by Garnier's great design for the Paris Opéra, but many of the smaller theatres show considerable departure from that superb type. Thus the Théâtre at Tours—one of the most recent in France—suggests no hint of the Opéra. It is not fortunately situated, the longer side being on a principal street, which is itself narrow, but is luckily cut by a side street, directly opposite which the central feature of the façade has been placed. This is a high arch, under a frieze carried by two engaged columns on either side, capped with a broken curved pediment, in the centre of which is a sculptured group. On each side the wall is divided into bays by shallow pilasters, with large

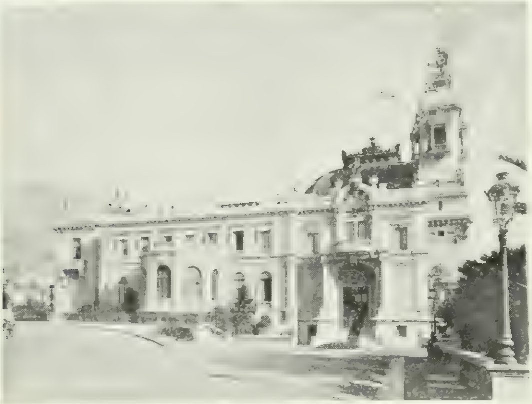


LA BOURSE, LE HAVRE.

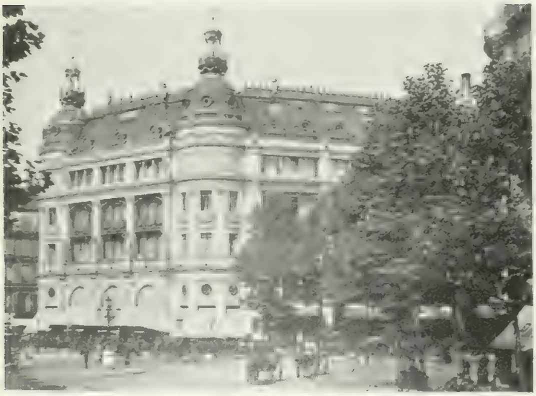
M. Lemâitre, Architect.



Théâtre des Arts, Rouen. M. Sauvageot, Architect.



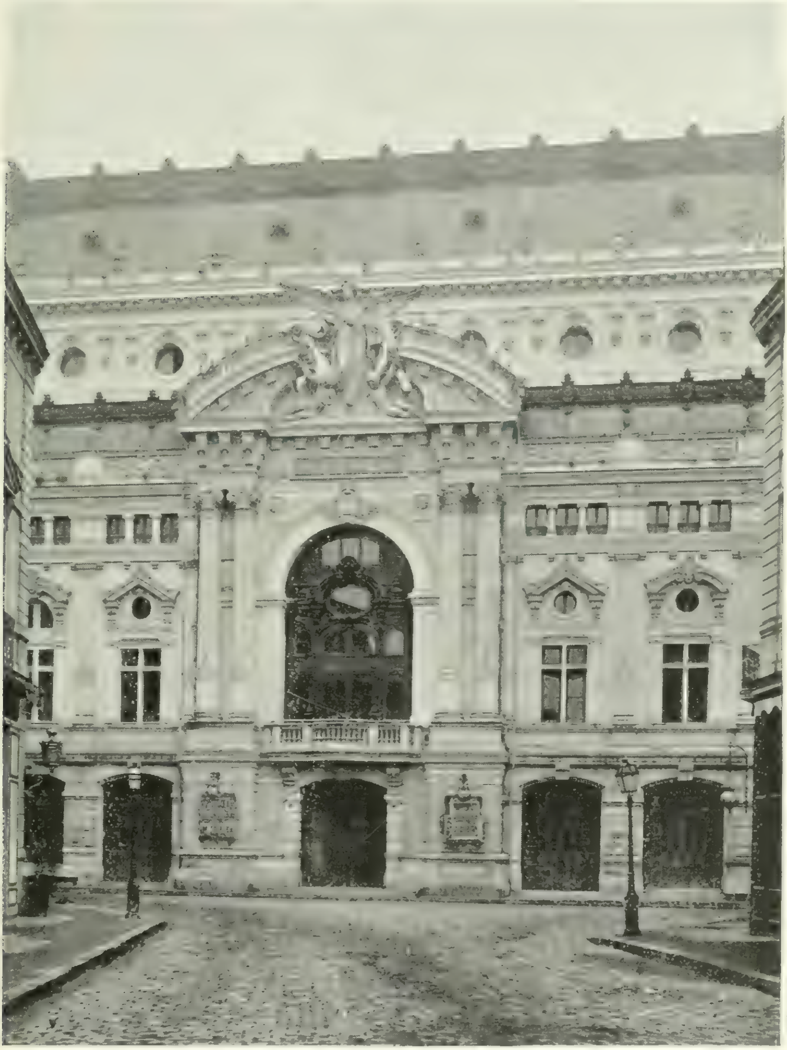
Théâtre, Monte Carlo. M. Garnier, Architect.



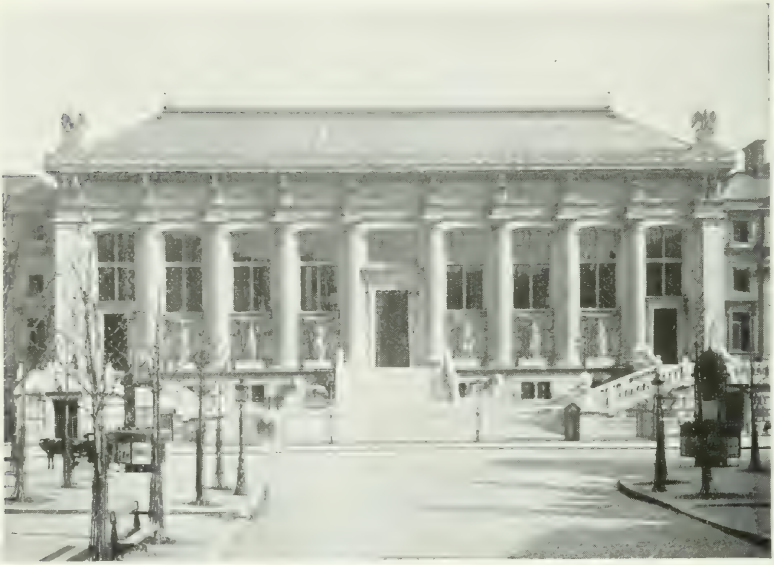
Magasins du Printemps, Paris. M. Lédille, Architect.

monumental windows between them, and at the top is a smaller series of windows, which is actually the frieze of the wall. The ends are formed by smaller pavilions similar to the central one. All of this is, of course, carried on a plain basement, which has segmental arched openings. Above the roof is an upper wall, or clearstory, lighted by small circular windows, and the whole is crowned by a high curved roof. The design is interesting both for itself and for its wide departure from the typical French theatre design.

The Théâtre at Angers shows another type of design. The central feature—three large windows separated by Corinthian columns—is flanked by small ornamental pavilions containing niches for statuary, and capped with curved pediments. These are repeated on the outer side of the large intervening arched windows, but with pilasters substituted for the engaged columns. These outer pavilions support small ornamental domes, while the central part has a broad frieze with circles containing busts, and above them a frontispiece with a large semicircular window and a curved pediment over all. This last quite hides the domes which mark the



THÉÂTRE, TOURS.



PALAIS DE JUSTICE, PARIS.

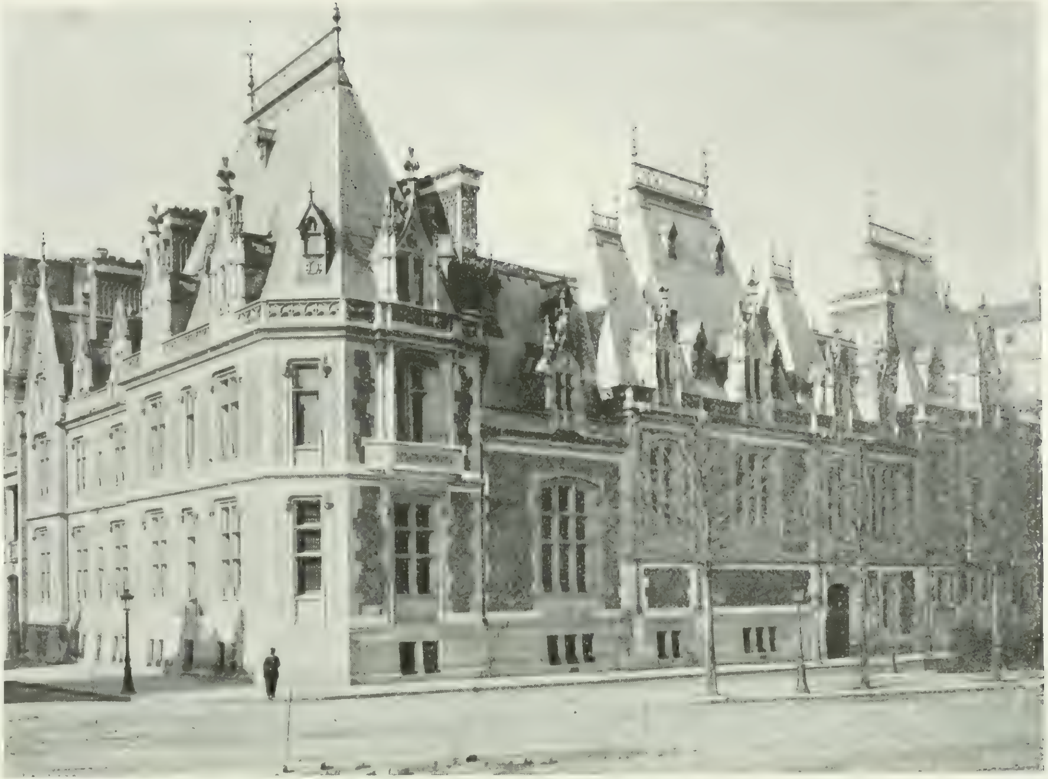
Façade of the Cour de Cassation. E. Viollet-le-Duc, Architect.

interior plan of the building. On each side are plain wings, whose lower portions are given up to business, this being one of the rather rare instances where commercial necessities are considered in conjunction with the purely pleasure giving function of a theatre. On the whole, notwithstanding the false top-piece, the architect has managed his commercial-pleasure combination with great ability. It should be noted that the two bulletin boards built into the piers on each side of the entrance, apparently for playbills and other notices, are not used for that purpose, rough board bulletins being placed below them.

Commercial architecture in France has nothing in common with commercial architecture in America. It is a purely French product, treated in a purely French way. Huge blocks of buildings, whose lower floors are given up to shops and cafés, and whose upper floors are used as flats, are often designed with some richness of detail, even though in itself it be poor and insignificant. Framed windows, with or without pediments, can usually be depended on, while nearly every floor will have its own balcony carried on carved corbels. These corbels have a singular uniformity in design : at their base they hug the wall as though stone were scarce and projection expensive ; but, suddenly, just under the balcony, they shoot forth into space as though their purpose as apparent supports had just been remembered, and the designer is seemingly so happy in the thought that he did not forget what he was about that he quite neglects to readjust the lower part of his brackets to his upper.

It need not be said that buildings of such a type scarcely suggest the commercialism that American business buildings do. They seem rather to be extensive blocks of dwellings whose lower floors have been turned into shops, than structures whose commercial ends were considered from the very outset. Even a gigantic place of business like the Hôtel of the Crédit Lyonnais in Paris—the largest private place of business in the capital, save the commercial emporiums—suggests nothing of the utilitarian ends for which it was built. Of the great dry-goods shops of Paris the most successful is the Magasins du Printemps. The Magasins du Louvre occupy an old hotel, and are as inconveniently arranged as it is possible to imagine. The Magasins du Printemps were built expressly for their present purpose. It is an interesting combination of stone, iron, and glass, with just that superabundance of ornament that only a Frenchman would think of applying to a commercial building. As a study in iron and stone, it

THÉÂTRE MUNICIPAL, ORANGE.



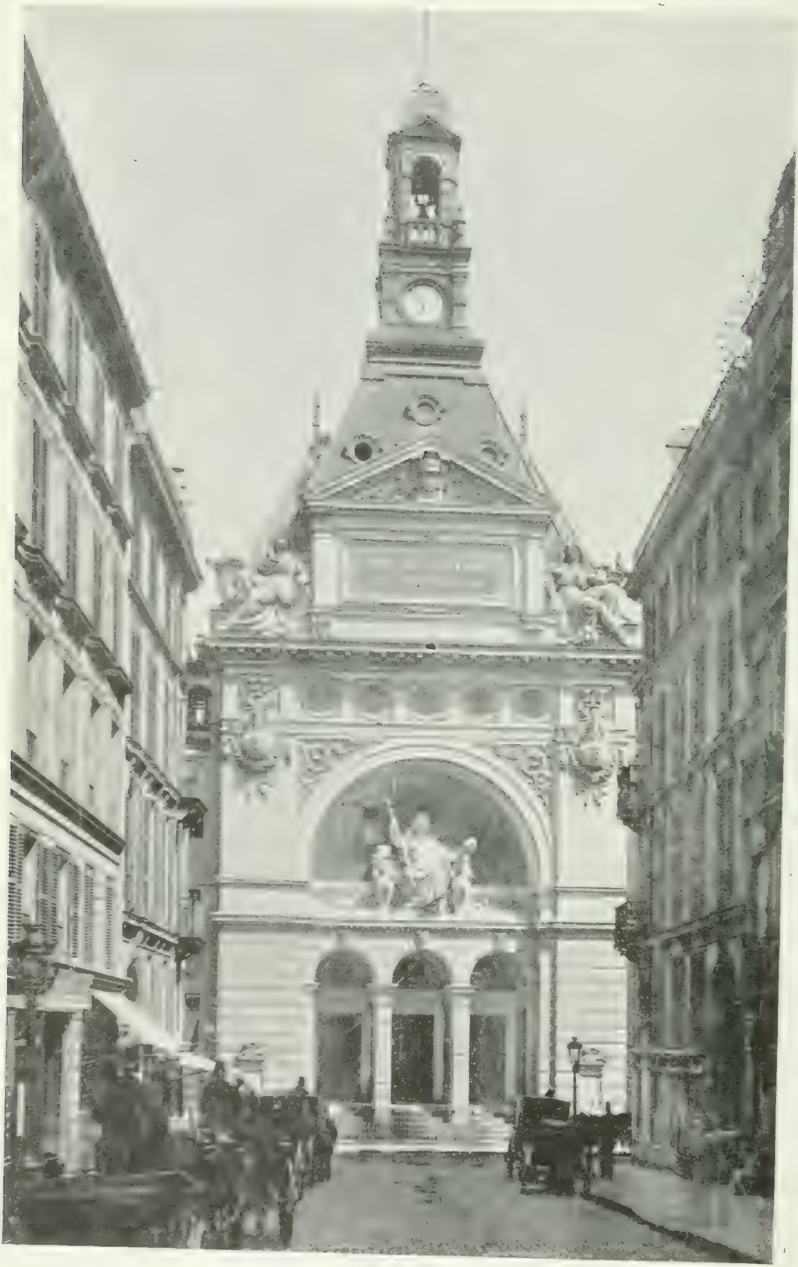
CHÂTEAU GAILLARD, PLACE MALESHERBES, PARIS.

M. Fevier, Architect.

is a far greater success than the singular church of St. Augustine, where the efforts of a "new architecture" are appallingly illustrated. It teaches a warning to those who wish to show iron when it is used in combination with stone that only the blind can ignore. Fortunately the experiment is an internal one; it need not be seen unless one goes within.

The eccentricities of modern French architecture are never seen to better advantage than in the dwelling-house. Few dwellings call for monumental treatment, though few French architects appear to be alive to that fact. Or possibly it is that here he reserves his skill for the production of the eccentric and the grotesque. The block dwelling in the city has already been referred to, and may be seen all over France with scarce a variation. The individual house is sometimes of considerable interest, though it is more apt to fall into the error of grotesqueness and over-enrichment of ornament. The single house is best seen in Paris, there being few really notable houses in the provincial cities, though a fine modern Renaissance house in Béziers may be noted in passing. Paris contains some good houses in the newer parts; the charming house of M. Gaillard on the Place Malesherbes may be cited as one of the most delightful of recent French domestic designs. The motif is the Château de Blois, and has been handled with consummate skill, the front being low and broad, with refined detail. The design is in striking contrast, in its stately beauty, to some recent pretentious houses in New York based on the same motif.

That there is much that is good in current French architecture, much that is fine, and some things that are great, it is folly to deny. On the other hand, it must be admitted, even by the sturdiest defenders of the French system, that the actual buildings do not come up to the standard of the School work itself. With this I would place the further statement that the quantity of interesting work, or of even tolerable work, is quite out of proportion to the reputation of the School. In other words, when a country maintains a costly system of education in architecture; when the great prizes of government building can only be gained by graduates in that system; when architecture is so much thought of that its management becomes a bureau of the national government,—something more than an occasional fine building should be found as a result. The land of France should be dotted with great works in architecture, instead of boasting of perhaps not more than a single half-dozen. The success of the School of Fine Arts is to be gaged by the actual buildings erected under its inspiration; not by its claims as to the benefits it confers upon its students. If the system is not strong enough to bear the test of experience; if its students cannot remember its lessons sufficiently well in the



COMPTOIR D'ESCOMPTE, PARIS.

M. Corroyer, Architect.

provinces and the smaller towns to live up to its teachings,—then surely we are justified in writing the word Failure across its record-book, and nothing remains but a winding-up of its affairs, and a disposal of its effects at the Hôtel Drouot.

It is not too much to ask for the maintenance of the very highest ideals in architecture in all important buildings in France. In no other country are the conditions for the production of fine work so admirable ; in no other land does the art stand closer to the people ; in no other land—it is scarce an exaggeration—are so many remains of fine old buildings with which new ones may be compared ; in no other land are the architects better trained or more fitted for their work. Yet, with all this extraordinary array of favorable circumstances, the modern architecture of France, taken as a whole, is no better than in any other country, and in very many cases it is distinctly worse. Its architects lack balance, as when they overload their buildings with ornament ; they lack appreciation, as when they fail to endow their buildings with feeling, which is one of the greatest, if not the greatest, of architectural properties ; they lack reasonableness, as when they try their hands at the invention of Orders and detail ; they lack refinement, as when they refine their ornament and detail to such a degree as to make the work actually deficient in projection and mass ; they lack sobriety, as when they cover their walls with pilasters, break up their fronts into unnecessary masses, and add meaningless appendages in the hope of ornamental result. That all these things may not be found in every building ; that some are more noticeable than others,—does not affect their general prevalency, or diminish the fact that, alone and together, they weaken the position of French architecture. It would be bad enough did such a state of things exist where the conditions were less favorable to the production of good buildings ; it is absolutely intolerable that it should be the fact in France.

Not the least preposterous claim made for modern French architecture by its votaries in America is that it needs to be understood in order to be appreciated. One needs to "get into the spirit" of modern French art before one can properly value its architectural form, we are told. Then everything will be lovely, and the newly-acquired convert can join in the chorus of self-adulation indulged in by his elders and betters. I do not know whether the French themselves make this claim or not ; I suspect they are too shrewd and endowed with too much common sense to tolerate such nonsense. Does current architecture in France,—architecture built by men living in our own time, under conditions we all can make ourselves familiar with, in ways and according to standards that have no occult properties of their own,—does such an architecture require a key and handbook, a course of lectures, a guide, a written explanation and decipherment, in order to be understood and appreciated? In some senses this may be true, for personally I find it quite impossible to follow some of my would-be guides in their admiration and enthusiasm for particular buildings. But surely never before was an architecture created of which such claims have been made. Architecture is not a closed book, not a thing distant from common folk (like myself), not something to be approached with bated breath and bared head, but an art that, more than any other art, stands close to people's lives,—an art that is nearer to human necessities, and does more for human safety and comfort, than any other form of art. There are no guides needed to the mysteries of modern architecture,—no signboards, no explanatory notices. If it cannot be seen and understood in the seeing, then it cannot and does not exist.

In the Opéra in Paris modern French architecture possesses one of the greatest triumphs of the art in this century. Faultless the building is not, but it is so grand an achievement, it is so superbly thought out, its designs so thoroughly reflect its planning and arrangement, its detail is so rich and lavish, and withal so good in itself, that one can approach it filled only with admiration for the man who designed it, with respect for his genius, and with admiration for his art. The Hôtel de Ville in the same city is another matchless monument which can only excite admiration and surprise that so superb a work could have been carried to successful completion. And in the Musée Galliera one of the most noted of living French architects has given to the world a building so refined, so graceful, so beautiful, so charmingly planned, so harmoniously composed, so exquisitely decked out with ornamental detail, that one can scarce find words wherewith to properly express one's delight in it. This veritable jewel among modern buildings is so delightful and exquisite that one feels almost tempted to forgive the system that gave its creator the skill to produce this masterpiece.

But we need more than a single Opéra, more than a single Musée Galliera, as the result of a lifetime of two hundred years. The School and its pupils should have more to show for themselves than these two buildings, great and noble though they be. It needs more than a few important government buildings in Paris to excuse the enormous expenditure the maintenance of the School has entailed in its two hundred years. The taxpayer of France, if no other person, has a right to demand more than an opportunity to train a few men of genius, and to ask for more than a handful of masterpieces,—literally less than one for each generation the School has lived. France should be filled with noble buildings of the very highest excellence of architectural art. The example of the School of Fine Arts should be seen in every city ; the power of its graduates should be manifested at every point. It should have more than a series of portfolios crowded with students' dreams as results. Taking the School as it stands, valuing its work as its pupils value it, elevating it to the exalted position given it by its American admirers—and this is perhaps as high, humanly speaking, as it can be got—there is nothing that cannot be demanded of it, no standard suggested that it cannot live up to. Yet, met on its own ground, it fails to come up to even the lowest limit of number and quantity, or to meet the most lax requirement of art and excellence.

Will the apologists for the School of Fine Arts produce an Abraham who will plead its cause in the number of its works? It is quite time he appeared, and his task is not one to be envied. Yet the very appearance of such a defender will be an admission of failure, a confession of weakness, an indication of shame. With all its vaunted energies, its boundless resources, its favored circumstances, the School of Fine Arts has not yet been able, after nearly two hundred years of continuous existence, to provide a general architecture for its own land that approaches, in any notable degree, the standard it itself sets for the paper work of its own young pupils. Its graduates and its professors are alike in their inability to competently handle the problems of real architecture with the same grace and facility with which they handle paper designs. Even the students in the School recognize this fact, since in their studies it is not erected buildings they take as their models, but the designs of their own predecessors prepared on paper for no other purpose than to be handed around and looked upon. Every modern building in France might be swept away, and, if the portfolios of the School should remain intact, it could still carry on business in the same old way, quite undisturbed by the physical change that had devastated the country.

The traveller in France, who wanders conscientiously from town to town, from department to department, seeking after the monuments of modern French architecture, and finding none, must conclude his journey with a feeling akin to stupefaction. How, with so little to show for it, with such inefficient designs, such thinly-scattered notable buildings, has the School of Fine Arts, Rue Bonaparte, Paris, gained such a tremendous and world-wide reputation? We are occasionally afflicted, in this unartistic land of America, with the blowings and trumpetings of advertisers and advertised articles. No American product, property, or possession, has ever been boomed with the strength, the persistency, the constancy with which the French School of Fine Arts has been boomed. And no product in the whole world has less solid ground behind it to excuse the uproar made on its behalf.

LESSONS OF THE ELBE DISASTER.

By Robert Gillham.

THE distressing accident to the steamship Elbe of the North German Lloyd Steamship Company, which was sunk in the North Sea immediately following a collision with the British steamer Crathie on January 30, 1895, resulting in the loss of three hundred and fifty lives, has made a deep impression on the civilized world. Much has been written about the safety of ocean steamships and the security found in the use of the modern transatlantic service. The success of the service is truly remarkable in view of the great improvements in steamers, securing great speed and superior comforts, and at the same time greater security against accidents. When great loss of life occurs at sea, due to accident or storm, the public look with horror on the perils of the ocean, forgetting for the time the horrors of a Johnstown flood, the forest fires of the North, the cyclones of the West, or conflagrations in cities, in all of which many lives have been lost. The loss of the Elbe will cause no more reduction in travel on the ocean than a collision on a railway causes in the use of railway trains.

The introduction of water-tight bulk-heads in the construction of modern steamships, sub-dividing transversely the hull into a series of water tight compartments, inspired greater confidence in the safety of ocean steamers. The sinking of the Elbe will result in many inquiries with reference to the value of her transverse bulk-heads, and will, no doubt, when the facts are known, prejudice the minds of many against those steamers having bulk-heads with doors through them.

We are informed that the Crathie struck the Elbe at a point where a bulk-head separated one compartment from another, and where the bulk-head joined the shell of the steamer, thus making it impossible to save the steamer on account of the rapid inflow of water into two compartments at the same time. This conclusion should be accepted with caution, for the reason that the flooding of any two compartments, where the same are of limited capacity and properly designed, and do not cover too much of the steamer longitudinally, would not cause the sinking of the steamer, unless the bulk heads separating the adjoining compartments had doors or other openings in them which, owing to the confusion following the accident, were left open, allowing the inflowing water to flood other compartments, and consequently the entire hull below water line, and thus causing a rapid sinking of the steamer. The facts indicate that the latter conditions were true in the case of the Elbe, as she filled very rapidly, and sank before many of the passengers and crew could be saved by launching the lifeboats.

Marine architects, in order to secure the greatest possible convenience, have in many steamships designed transverse bulk-heads with doors so constructed that, in the event of accident threatening to flood the steamer, they can be closed and the compartments be made water tight.

It adds to the attractiveness of a steamer to be able to walk two-thirds of its length through an electrically-lighted passage-way between staterooms, passing through doors from one compartment to another; but, when these openings are below water line, the value of the bulk-heads is greatly lessened. They are still valuable in giving stability to the structure of the steamer, but any opening in a transverse bulk-head below water line is an added element of danger in the event of flooding of the compartments.

Accidents at sea occasion more or less excitement and disorder. No matter how competent the officers may be, or how thoroughly the crew may be drilled, it often happens that members of the crew delegated by the officers to perform important duties after an accident, fail utterly, on account of their excitement, to carry out the instructions; and serious consequences follow. The accident to the steamship Oregon a few years ago, off Long Island, is a case in point. A small sailing vessel drove a hole through her shell, and water began to flow in rapidly. The crew failed to close the doors in the bulk-heads, and the water could not be confined, resulting in a general flooding of the steamer and causing her to sink in a very short time. A smooth sea, and vessels near the scene, prevented serious loss of life.

Accidents other than collisions have occurred that have broken the shell; consequently there are dangers to be feared other than that of running into a great iceberg, steamer, or sailing vessel in a dense fog or at night. The case of the City of Paris is interesting. In March, 1890, when about 240 miles from Queenstown, the low-pressure cylinder of the starboard engine, through defects in the securing of the piston to the piston-rod, was broken to pieces. The high-pressure engines working with the low-pressure engine ran away, when the low-pressure engine's piston broke from the rod, reducing a large portion of the machinery in the starboard engine-room to scrap, and at the same time knocking a hole through the bottom of the steamer 20 ft. below water line. The flow of water through this opening was very rapid, requiring only a short time to flood the engine-room. It was supposed that the accident would not result seriously, for the reason that, the steamer being provided with duplicate engines and twin propellers and having also entirely independent engine-rooms, separated by a water-tight bulk-head arranged longitudinally along the inner side, the inflowing water ought easily to be confined in the starboard engine-room, while the steamer continued its journey to Queenstown by means of the port engine. These hopes were soon abandoned when it was discovered that the port engine-room was filling with water almost as rapidly as the starboard engine-room. A door which had been placed in the longitudinal bulk-head between the engine-rooms was opened shortly before the accident, and some one forgot to close it. There was also a hole broken in the bulk-head when the starboard engine went to pieces. Here were two 10,000 h. p. engines absolutely useless under from 16 to 20 ft. of water. Besides these great engines, the electric-light generators, the circulating pumps that operated the steering apparatus, the machinery used in loading and unloading the vessel, and that used in dropping and raising the anchor, all of which were operated by hydraulic machinery controlled by pumps located in the engine-room, were disabled. The vital parts of the ship were submerged. No light at night, save a few oil lamps and tallow candles. The accident to the City of Paris to some extent demonstrated the fact that it is unwise to concentrate all the auxiliary machinery and pumps in the engine-room. The nine hundred persons on board at the time of the accident can thank water-tight bulk-heads and a calm sea for the preservation of their lives. The transverse bulk-heads in the Paris had no openings or doors below water line. If communication became necessary between compartments, passengers and crew were required to go up-stairs to the main deck above water line, and down again to the compartment with which communication was desired. In the opinion of those competent to judge and familiar with all the facts, the Paris would have gone to the bottom within a short time after the accident, had there been doors in the bulk-heads, as it is very doubtful if they could have been closed in time to avoid a general flooding of the steamer. The Paris floated about helplessly at the bidding of the wind and waves, first on the crest of a great swell, then down in the trough of the sea, drifting slowly with the ocean current from Tuesday afternoon until the following Friday before relief came. The passengers did not leave the steamer until Sunday. Each day added many tons of water to that already in the steamer, until something over three thousand tons had flown into her and flooded the compartments abaft the engine-rooms. The steamer settled lower and lower as the days came around, and, while there were no openings in the transverse bulk-heads, the water forced itself into the compartments abaft the engine-room principally through the man-holes used as means of access to the shaft alley. The shaft passed from the engine-rooms to the stern tube through a water-tight steel casing called the shaft alley, which ran through the compartments abaft the engine-room, but was shut off entirely from them except where shaft bearings were located, these man-holes being provided, with man-hole plates tightly secured to the casing. When the engine-room became flooded, there was nothing to prevent the water from running back through the shaft alleys and below the compartments abaft the engine-room to the stern tube where the shaft leaves the hull of the steamer. The head of water in the engine-room was so great that it forced the water under the man-hole plates out into the compartments referred to, and it was not long before these compartments were partly filled with water. Another source of trouble was found in the weakness transversely and lack of rigidity of the bulk-heads under water pressure. The leakage in some places between the plates was considerable, when they should have been absolutely water-tight. This was particularly true where large areas of the bulk-heads were exposed without intermediate supporting plates or angles. The steamer settled until she drew 33 ft. of water at the stern and only 16 ft. at the bow, or 17 ft. more at the stern than forward. She would have gone down stern first, as did the Elbe. Such was the condition of the Paris when towed to Queenstown.

Here we have a case where a steamer provided with the most improved bulk-heads, flooded as described, could not have weathered a storm or remained above water very much longer without aid.

It is important to so improve the water-tight bulk-head system in steamships that one compartment may be flooded without in any manner endangering the other compartments. Many believe that this result has already been secured; but, when leaky seams, and light construction, and weak plates, and doors or other openings in bulkheads and shaft alleys are considered, it is evident that there is room for further progress. The best practice is opposed to openings of any kind in the bulk-heads below water line, favoring means of access between compartments only above water line.

The writer once suggested that special means should be supplied, if possible, that would effectually exclude water from compartments after flooding. If this can be accomplished, greater safety will be secured to the service.

The vital parts of a steamer, or engine- and boiler-rooms, should be so arranged that, in the event of either being flooded, they can be closed and made air-tight. Steamers should be provided with air compressors, and perhaps auxiliary steam-supply of small powers. The compressed air should be forced into the flooded compartments at such pressure as would expel the sea-water through the openings in the shell back into the ocean, after which the repairs necessary to permit the steamer to proceed could be made to either machinery or shell.

If necessary, the engine-room or compartment repaired could retain air pressure until port was reached. By the use of temporary air-locks as means of access to these compartments, there would be no difficulty in operating these rooms, and no trouble in working men or machinery under considerable air pressure. Any compartment could be treated in the manner described, if properly arranged. Had it been possible to close the sky-lights above the engine-rooms of the Paris, and make the engine-rooms practically air-tight, compressed air at a pressure of about 10 lbs. to the sq. in. would have expelled nearly all the water from the engine-room; the bulk-heads between the engine-rooms could then have been repaired, the door closed, and the port engine used for the purpose of reaching port. There was no difficulty or trouble with the port engine, and, if the water could have been kept out of the port engine-room until the bulk-head between these rooms had been repaired, according to the theory upon which this steamship was built, the port engine could have been operated, even though the starboard engine-room was flooded. After forcing the water by air pressure from the starboard engine-room, if it had been discovered that repairs to the shell could not be made, the air pressure could have been maintained in the engine-room, which would have kept the water from returning into the room. The practical application of suggestions here made is, of course, surrounded with many difficulties, and I doubt not naval architects and practical shipbuilders can cite objections seemingly insurmountable. But, in the light of events, and from a logical standpoint, the use of compressed air in excluding water from compartments flooded on steamships is worthy the closest consideration. A careful study of the subject may develop practical methods for its introduction, not only on ocean steamers, but on ships of our navy, for the purposes indicated. There can be no question that there is great room for improvement in providing special means for the safety of life on ocean steamers; and, in considering improvements in the construction of transatlantic steamers, methods of construction may be developed that will practically make the steamers unsinkable and secure a much higher degree of safety.

GOLD PRODUCTION IN COLORADO.

By W. C. Wynkoop.

WHEN the price of silver fell from 80 to 60 cents per ounce in the summer of 1893, the effect was remarkably severe upon the industries of Colorado. Directly and indirectly three-fourths of the population of the State depended upon silver mining. Gold mining formed but an insignificant part of the great industry. At once silver mines closed down, and in every mountain town and camp crowds of men were thrown out of work. The feeling was one of dismay, or desperation. Men who were single packed their few things into bundles and started, generally on foot, for some other region, in search of work and wages. Few of those who had money would pay it to railway companies for fare, and often crowds took possession of railway trains and were hauled for nothing. For a short time the trouble on the railways became so great from the crowds who were "beating their way" that the companies issued orders to conductors to carry free those men who were leaving the country, and who were unable to pay fare. Some mining camps, of minor importance, were entirely depopulated. The freights on the railways naturally fell almost to nothing. On some of the branches from main lines into mining towns or camps the daily train gave way to a semi-weekly or weekly train. In every department of industry where men are employed, there was a partial or entire stoppage. The unemployed crowded into the larger cities, in each one of which measures for their relief were adopted.

In the mining regions those who had families, or who owned property, were practically the only ones who remained. To make a living, or get something to eat for their families, they were obliged to take leases, or go "gophering" around among deserted mines and prospects, getting a little ore here and there, out of the sale of which, even at the greatly reduced silver prices, they could buy the bare necessities of life. The leasing system, then enforced by the impossibility (in most cases) of paying wages, yet continues, and, no matter what the future of silver may be, will doubtless always be more of a custom than it has been in the past.

Naturally the decline in the price of silver forced men to an effort to find gold. Though Colorado was founded upon gold mining, and though for several years no other mining was carried on, the gold resources were considered so much inferior to the silver resources that they were largely neglected. The few parts of the State (confined mainly to a portion of five counties) whose principal source of wealth was gold mining were slowly declining, and were certainly not gaining, if they were not losing, in population. Out of twenty counties which can be classed as mining counties, fifteen whose principal source of wealth had been silver mining were constantly gaining in assessable property and population. Thus silver mining became the basis of the State's prosperity. Agriculture, manufacturing, commerce, and transportation depended almost wholly upon these silver-mining regions, which furnished the market for products and by far the greater part of the business for more than 2000 miles of railways. The present condition shows a change to the other extreme. All the attention of prospectors, capitalists, and investors appears to be directed to the gold-producing regions.

The men who lost heart and courage after the "silver smash," as it is commonly called there, were not the old-time, or skilled, miners. The latter generally turned their attention to gold production. Most of them, for want of capital, were forced to seek the golden grains in creek bars and beds, where the appliances were a pan, rocker, or long tom. In this way they could wash out in many places enough to furnish the barest necessities of life, and this, to the real miner, is always far preferable to seeking charity. At one time, in the autumn of 1893, there were at least three hundred men washing gold with pans or rockers within sight of Denver, making probably an average of 50 cents each per day. On this beautiful and mild 24th day of February, 1895, there are a dozen or more men washing gold in pans within the city limits of Denver, and making enough to buy bread and meat by so doing. By far the greater part, however, of the miners and prospectors who were forced into want in July, 1893, have directed their attention to prospecting in other parts of the State, where, if the reward for labor may be less and the certainty nothing, they can hope for better returns. Some of them have been very successful. The inevitable result is the widening of the proven profitable gold-producing part of the State, and an addition to the number of gold-producing properties.

The United States mint report gives the value of the product of gold in Colorado in 1893 at $7,487,071, and in 1894 at $10,616,463,—a gain of 41 per cent. Should the gain for 1895 over 1894 be at the same ratio, the product for the present year will equal $15,000,000. I think it is safe to place it at that amount.

Whether the gold resources of the State are sufficient to warrant a belief in a corresponding increase of 41 per cent. per annum for any considerable number of years is an interesting question. Of course no one can say that such an increase is probable for two, three, or any other number of years. It may be for two years, but he would be a rash man who would predict any probability of such a thing for any longer period.

But it is certain that, in the wild scramble for silver mines which have existed for a dozen or more years, the gold wealth of Colorado has been overlooked. In the search for the great prizes of silver ore the modest rock which carries from $5.00 to $10.00 per ton in gold has been neglected. The public have only lately begun to see that there is a good deal of profit to be made out of the despised low-grade gold-bearing rock, as well as that the geological conditions throughout the State, as a whole, are more favorable to gold existence than has been supposed by any except the geologists and engineers who have given the subject attention. But, while the latter have often predicted what is now seen, the tangible results of their cautious teachings have been slow in appearing. The discoveries of mines are not usually made by geologists, but by prospectors, and the latter are the most notoriously bigoted men in regard to theories that can be found. For almost thirty years in Colorado, at least, they have, as a rule, been wedded to the idea that gold could not and would not be found in lodes, in paying quantities, except where the lodes exist in granitic or eruptive rocks. Now they are learning that this is not so, and the results of the lesson will be seen in the increased production of gold in the west. The old, granitic gold-bearing regions are all well known, and to some extent have all been prospected. They naturally will increase their product, year by year, for some time to come, because more attention is being constantly given to their development. But the great increase, if there is to be any, cannot be expected from these regions. In fact, within a comparatively short time they must show a decrease, because the life of a mine, like that of an individual, can not go on forever. A ton of ore extracted can never be replaced, and the time is rapidly coming when the world must rely for its gold and silver supply upon new discoveries. The question then becomes one of the probabilities of such discoveries.

The gold-producing regions of Colorado, where that metal constituted the greatest portion of the value produced, was confined to about 500 square miles, all in five counties. Gold was produced to some extent in every mining county, but outside of these regions it was associated with silver in ore, and formed but a small part of the value.

The Leadville "gold belt" has done more to awaken attention to the probabilities of finding gold-bearing rock outside of veins in granitic rock than any other one thing. By the "gold-belt" is meant the country surrounding Leadville in which gold-bearing ore is found on the same geological horizon in which it is found in that great mining camp. That horizon belongs to paleozoic time, in the lower silurian rocks. The lesson, in its narrow and generally understood limits, is that where these rocks can be found, cut by porphyritic dykes and broken by dynamic disturbances, good ore in some quantity exists. This much appears to be certain,—that the best deposits of ore, both gold and silver, are found where the country is most broken and shattered by dynamic forces, and where porphyry dykes are most abundant. The word porphyry is used in a generic instead of a specific sense. Porphyry has become, by common usage, the name applied to all eruptive rocks. Narrowing the observation, gold appears as though gold is found most abundantly associated with the acid rather than the basic porphyries. Narrowing it still further, gold appears to be found more plentifully associated with those porphyritic rocks in which soda, rather than potash, forms the alkaline composition. This, in the present stage of knowledge about gold occurrence, appears to be the situation.

Speaking generally, it can be said that Colorado has about 8000 square miles in which the geological conditions are favorable to the discovery of gold-bearing ore in paying quantities. That many places like Leadville and Cripple Creek (the productive portions of which did not cover more than 20 square miles) can be found, no one can predict. All one can say is that in these regions scarcely more than one per cent. of the country has been well prospected. But, while there may not be another Leadville or Cripple Creek, there are surely other productive mines, the discovery of which would add greatly to the aggregate of the value produced. What is said about Colorado's possibilities for gold production is probably true, to a less extent, about all the mountain mining country. Certainly there is every reason to believe that all the rich things have not been found. Though the clouds may not have a silver lining, they have a golden tinge, and this is giving a growing ruddy glow of hope to the far west. Hope is always a strong element in prosperity, as it is in happiness. It may be that "the crown of the continent" has been a golden crown, plated with silver, and that the fact is just being discovered. At any rate, so long as gold is the trump, the mining States will hold the best hand.

THE BURNING OF TESLA'S LABORATORY.

By Thomas Commerford Martin.

OF Tycho Brahe's famous observatory at Uraniburg remain to-day but a mound of earth and a couple of holes. The same inventory would aptly apply to all that is left of the upper floor where Nikola Tesla has of late years been carrying on his suggestive and beautiful demonstrations in electricity. Two tottering brick walls and the yawning jaws of a sombre cavity aswim with black water and oil were all that could be seen on the morning of March 13 of a laboratory which to all who had visited it was one of the most interesting spots on earth. Beset by the squalor and clamor of plebeian South Fifth Avenue, the building was unpretentious, and its lower stories were given up to the prosaic details of an iron-pipe cutting business. Commonplace also was the origin of the disaster. A flaring gas jet, oil-soaked floors, and a "watchman" have been heard of before as an effective combination for midnight fires.

It has been curiously pathetic to note how universal was the expression of sympathy with Mr. Tesla in his loss. The newspaper dealers in the marvelous had been so relentlessly active in attempting to describe what they imagined to be going on in the laboratory that they experienced no difficulty in arousing regret as to the magnitude of the loss. But even now, if the average citizen were asked to explain definitely what he was grieving about, he would hesitate to answer. Impressions as to the laboratory have been mixed and weird. For example, one vivid young lady of the press, in her anxiety to be instructive, went so far as to depict herself undergoing a brilliant electrical ordeal that is possible only with the body entirely naked. This grotesque kind of misrepresentation has had vastly more terrors for Mr. Tesla than even the grim episode of last month. Nothing is so absurd as to suppose that inventors of his stamp relish the derogatory *persiflage* of the highly-colored articles that purport to reveal them and their work to the lay public. On the contrary, if it were not all so puerile, it would agonize men striving simply after scientific results and appreciative solely of scientific approval thus to be depicted in the *rôle* of charlatans,—that of a

> Katerfelto, with his hair on end,
> At his own wonders wondering for his bread.

Happily, the Tesla laboratory was visited not alone by irresponsible purveyors of popular misinformation, eager for a new topic to be handled with exhaustive inaccuracy. Happily, the selfish lion-hunters of society have not been the only other class to which Mr. Tesla had an opportunity of presenting, with his unwearied good nature, new theories, new phenomena, and new apparatus. Happily, before the copper, glass, and insulation melted, physicists, electricians, and representative men in art and literature were able to see and judge for themselves what was forward. Indeed the pressure to secure an *entrée* to the laboratory had of recent months been extreme; and, now that the fire has occurred, perhaps it is as well that Mr. Tesla's imperative refusals once and again had their edges turned. The occasions are certainly rare when an inventor draws general notice to himself; and this is natural, for inventions deal chiefly with outward, material things. A poet or an artist can enter by his work into the life-blood of a people, and becomes part of their soul and growth. An ordinary inventor is more often like a man cutting his initials high up in the young bark of a sapling. The stem rises and expands, but the notches harden and stay ever at the same height, and are foreign to the tree's vital processes. At rare intervals the public becomes dimly conscious of new inventions that touch the arteries of social being; and then it is vaguely, but deeply, stirred. These inventions are generically such as affect and change our methods of obtaining light, heat, and power, our modes of travel, and the transmission of intelligence. The public had learned, more by intuition than knowledge, that Mr. Tesla was at work in each of these fields.

The Tesla laboratory was, in a sense, a private museum. The owner kept in it many souvenirs of bygone toil and experiment, and an important part of his records. During the past ten years Mr. Tesla has done an enormous amount of original experimentation, and it was all represented in the contents of the laboratory. His priority and preeminence in the polyphase current domain, which has been created by the development of his principle of the "rotating field," was richly exemplified by models and parts of single, two, three, and multiphase motors of all kinds. Some of the pieces showed how careful of his material the inventor always was. A close observer could discern that he had used it sometimes a dozen ways in a dozen forms. Readers of the ENGINEERING MAGAZINE may remember to have seen these relics in Electricity Building at the World's Fair, as well as the curious ring wound for two-phase circuits over a smooth disc upon which copper balls revolved at wild speed, or near which other bodies could be set spinning rapidly. This illustrated graphically the manner in which Mr. Tesla was able in his motors to dispense with commutators and brushes. Another notable class of apparatus in the laboratory was that employed for researches into the qualities and effects of currents of high potential and high frequency. Mr. Tesla's name is peculiarly associated with this work, and his too infrequent lectures have described a wide range of results obtained in lighting novel electric lamps, or empty bulbs, in free space, without any connection with the distant wires or machinery. In this group may be included his early dynamos for generating high-frequency currents, one of them giving as high as thirty thousand alternations per second ; and of equal interest were the disruptive discharge coils designed and built specially to demonstrate a number of recondite and startling discharge phenomena. There were also several unique appliances with which novel conditions could be studied in insulation, induction, impedance, and resonance.

But that which was of largest interest to everybody was the group of oscillators. In the new machine to which he gave quite appropriately the name of "oscillator," Mr. Tesla had blended or merged the dynamo and steam engine, seeking thereby to secure a far higher efficiency than both could give individually at their best. It is curiously typical of the man that he had no sooner placed in the hands of electricians the means for the economical long-distance transmission of water powers—his system being adopted widely, for example, at Niagara—than he threw himself on the problems of getting electrical current more cheaply from steam ; and that, while lavishly generous in personal intercourse, he is ever fighting savagely the waste that goes on in our utilization of Nature's resources. It is something to have rendered the waterfalls more useful, but one's sympathies must equally go out to work that is aimed at greater economy of coal. If each 10 hours' work of 1 h. p. from a steam engine requires a total of 6 tons of coal every year, and if that is subject to further tremendous losses when turned into electric current, it is worth the effort to aim at less wasteful processes. This is the goal of Mr. Tesla's oscillator, and he is sanguine enough to believe that he has reached it.

The oscillator is simply a steam chest dissociated from all the orthodox governing mechanism, and joined in a new partnership with sets of electro-magnetic coils, into whose fields of force it thrusts reciprocatively armatures carried by its pistons, the regulation being subtly accomplished by the currents that are thus set up. The reduction in bulk is very striking, but obvious ; while the reduction in steam consumption and the higher value of the currents are both elements that Mr. Tesla believes he has insured to a significant degree. He makes few mistakes.

Only one oscillator had ever been shown in public,—that, namely, which Mr. Tesla used in his lecture before the Electrical Congress at Chicago, in August, 1893, employing compressed air as the working fluid, for convenience. That machine and later types were all to be seen at the laboratory. The most advanced form shown to visitors was a very neat mechanism, entirely practical and successful, by means of which the laboratory had been lighted for months as well as furnished with current for the work done with the high-frequency apparatus alluded to above. It was run at 350 lbs. steam pressure; but, although there was no packing, no leakage of steam could be detected. Two pistons vibrated in opposite phase eighty times per second. The vibrations of these pistons past two sets of electromagnets developed current that was led to a bank of fifty or sixty incandescent lamps, which were lighted up to full candle-power and were steadiness itself in illumination. Current was also furnished by the machine to four arc lamps and to motors, as well as to devices of a fascinating nature, by means of which Mr. Tesla would light up tubes or ordinary incandescent lamps in the centre of the laboratory,—a room perhaps 40 feet by 80. He also used the current to experiment boldly with the electrical charge of the earth itself. One cannot but regret that all these first fruits of penetrative investigation have gone down in the wreck at South Fifth Avenue. They are being swiftly reproduced by incessant labor on the part of the dauntless inventor, but as the first, and, for awhile, the only exemplars of their kind, they are now touched with a sentimental interest unworthy neither of those who feel it or of the objects themselves.

Perhaps the most painful loss of all is the destruction of Mr. Tesla's notes and papers. His memory is all right, and flashes on any experiment of the past with the revealing power of a search-light; but when can leisure now be won to jot things down that, marking achievement on one hand, might also save other experimenters years of toil, and that would show to capital as well the doors open as the paths that are blind. The loss falls least heavily on the loser. Like many another tireless experimenter, he hoped to give the world with due rapidity the report of his failures as well as of his discoveries, but he had not counted on casual destruction of memorabilia by fire as one of the obstacles in his way. Mr. Tesla had taken the papers to his laboratory so that he might work on them in brief leisure spells, and was thus the victim of his own conscientious endeavor to be of use to his fellow-electricians. There seems to be a fate about such things. Galileo's own son, from filial religious motives, destroyed some of his father's dearest manuscripts; and it was no less a friend than John Stuart Mill who burnt up for poor Carlyle the first volume of the unprinted "French Revolution." It took Carlyle four weeks, and heaps of the trashiest novels, to quiet his mind after the miserable accident. Tesla was at work again with clenched determination while the ashes of his hopes lay hot.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

INTRODUCTORY.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance ; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

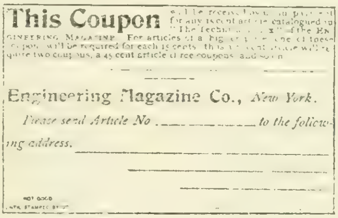
We hold ourselves ready to supply—usually by return mail—the full text of every article reviewed or indexed, and our charge in each case is regulated closely by the cost of a single copy of the journal from which the article is taken.

☞ The price of a single article is ordinarily 15c. ; those indicated by an asterisk (*) 30c. ; by a dagger (†) 45c. ; and above this, the price is given just after the number. In ordering from us care should be taken to *give the number* of the article desired, not the title alone.

The entire Review is conveniently classified into the recognized divisions of applied science—everything pertaining to "Architecture and Building" appearing under that heading, while "Civil Engineering" is given under that title, and so on alphabetically throughout. The titles, addresses, and initials of all the journals regularly reviewed are given alphabetically below, but in the body of the Index only the initials are given. Other abbreviations used are, Ill=Illustrated; W=Words.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell coupons—represented here in miniature.

The price of these coupons is 15c. each, or fifteen for $2, forty for $5, and one hundred for $12.



This Coupon

Engineering Magazine Co., *New York.*

Please send Article No __________ *to the following address.*

Simply fill in the number, and your address. A stamped envelope does the rest. No letter-writing is required.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their great convenience and economy.

THE PUBLICATIONS REGULARLY REVIEWED.

A	Arena. *m.* $5. Boston.
AA	American Architect. *w.* $6. Boston.
An A A	Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An	American Analyst. *f.* $1. New York.
A & B	Architecture and Building. *w.* $6. N. Y.
A B D	Arch. Build. and Dec. *m.* $2 Minneapolis.
A C J	Am. Chem. Journal. *b-m.* $4. Baltimore.
A E C U	Asso of Eng. of Cornell Univ. 1894. Ithaca.
A E R J	Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G	Am. Geologist. *m.* $3.50. Minneapolis.
A G L J	Am. Gas Light Journal. *w.* $3. New York.
A J S	Am. Jour. of Science. *m.* $6. New Haven.
A L	The Architect. *w.* 26*s.* London.
A M	American Machinist. *w.* $3. New York.
A M C	Amer. Mag. of Civics. *m.* $3. New York.
Am M	American Miller. *m.* $2. Chicago.
Am S	American Shipbuilder. *w.* $2. N. Y.
A M & I W	Am. Man. and Iron World. $4. Pittsburg.
A M S	Aust. Mining Standard. *w.* 30*s.* Sydney.
A R	Architectural Record. *q.* $1. New York.
A Rev	Architectural Review. *s-q.* $5. Boston.
A S	Age of Steel. *w.* $3. St. Louis.
A S I E	Amer. Soc. of Irri. Eng. *qr.* $4 Denver.
A S M E	Am. Soc. of Mec. Eng. *m.* New York.
B	The Builder. *w.* 26*s.* London.
B A	The British Architect. *w.* 23*s.* 8*d.* London.
B B	Brick Builder. *m.* $2.50. Boston.
B G S	Bul. Am. Geog. Soc. *q.* $5. N. Y.
B I S	Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C	Boston Jour. of Commerce. *w.* $3. Boston.
B M	Banker's Mag. *m.* 18*s.* London,
B M A	Bankers Mag. of Australia. *m.* $3. Melbourne.
B T J	Board of Trade Journal. *m.* 6*s.* London.
B U W	Bul. of the Univ. of Wisconsin.
C A	Calif. Architect. *m.* $3. San Francisco.
Can A	Canadian Architect. *m.* $2. Toronto.
C & B	Carpentry and Building. *m.* $1. New York.
C E	Colliery Engineer. *m.* $2. Scranton, Pa.
C Eng	Canadian Engineer. *m.* $1. Montreal.
C G	Colliery Guardian. *w.* 27*s.* 6*d.* London.
Ch	Chautauquan. *m.* $2. Meadville, Pa.
C M	Century Magazine. *m.* $4. New York.
C M R	Canadian Mining Rev. *m.* $1.50. Ottawa.
Com	Commerce. *w.* 36*s.* London.
Cos	Cosmopolitan. *m.* $1.50. New York.
C R	Contemporary Review. *m.* $4.50. London.
C T J	Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
D E	Domestic Engineering. *m.* $2. Chicago.
E	Engineering. *w.* 36*s.* London.
E A	Electrical Age. *w.* $3. New York.

E & C....Engineering & Contractor *w.* $1. San Francisco.
E A S....Eng. Asso of the South. *m.* $3. Nashville.
E E ......Electrical Engineering. *m.* $1. Chicago.
E E L....Electrical Engineer. *w.* 19s. 6d. London.
E E N Y..Electrical Engineer. *w.* $3. New York.
E G.......Engineers' Gazette. *m.* 8s. London.
E I........Electrical Industries. *m.* $1. Chicago.
E L........Electricity. *w.* 7s. 6d. London.
El.. ......Electrician. *w.* 24s. London.
E M.......Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.......Engineering News. *w.* $5. New York.
Eng.......Engineer. *s-m.* $2.50. New York.
EngL... Engineer. *w.* 36s. London.
E N Y....Electricity. *w.* $2.50. New York.
E P.......Electrical Plant. *m.* 6s. London.
E R.......Engineering Record. *w.* $5. New York.
E Rev....Engineering Review. *m.* 7s. London.
E R L.....Electrical Review. *w.* 21s. 8d. London.
E R N Y..Electrical Review. *w.* $3. New York.
E S W P...Proc. Eng. So. of W.Pa. *m.* $7. Pittsburg.
E W.......Electrical World. *w.* $3. New York.
F.........Forum. *m.* $3. New York.
F D.......The Foundry. *m.* $1. Detroit.
F R.......Fortnightly Review. *m.* $4.50. London.
F W.......Fire and Water. *w.* $3. New York.
F'y.......Fairplay. *w.* 32s. 6d. London.
G E M...Gas Engrs' Mag. *m.* 6s. 6d. Birmingham.
G & F....Garden and Forest. *w.* $4. New York.
G M.....The Geol. Mag. *m.* 18s. London.
G R.......Good Roads. *m.* $1. New York.
G W.......Gas World. *w.* 13s. London.
H & V...Heating and Ventilation. *m.* $1. N. Y.
I A.......Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
I E........Indian Engineering. *w.* 18 Rs. Calcutta
I Eng....Indian Engineer. *w.* 20 Rs. Calcutta.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25s. Lond
I C B.....Carpenter and Builder. *w.* 8s. 8d. London.
I C T......Iron and Coal Trades. *w.* 30s. 4d. London.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
Inv.......Invention. *w.* 11s. London.
Ir Age..Iron Age. *w.* $4.50. New York.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J G L....Journal of Gas Lighting. *w.* London.
J N E W.Jour.N.E.Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J S A....Journal of the So. of Arts. *w.* London.
L A......The Landscape Architect. *m.* $1.50. Rochester.
L E......Locomotive Engineering. *m.* $2. N. Y.
L. H. P..Light, Heat and Power. *m.* $3. Phila.
M........Machinery. *m.* 9s. London.
M A.....Machinery. *m.* 50 cts. N. Y.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M E......Marine Engineer. *m.* 7s. 6d. London.
Met W...Metal Worker. *w.* $2. N. Y.
Mill......Milling. *m.* $2. Chicago.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
Min W..The Mining World. *w.* 21s. London.
M J......The Mining Jour. *w.* £1. 8s. London.
Mo ...The Monist. *qr.* $2. Chicago.
M R......Manufacturer's Record. *w.* $4. Baltimore.
M S F....Master Steam Fitter. *m.* $1. Chicago.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M W.....Mechanical World. *w.* 8s. 8d. London.
N....... Nature. *w.* $7. London.
N A R...North American Review. *m.* $5. N. Y.
N B......National Builder. *m.* $3. Chicago.
N C......Nineteenth Century. *m.* $4.50 London.
N C B...National Car Builder. *m.* $2. New York.
N S R....The New Science Review. *qr.* $2. N. Y.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
P.........Paving. & Mun. Eng.*m.* $2. Indianapolis.
P A......Progressive Age. *s-m.* $3. New York.
P E C P.Procd. Engineer's Club. *q.* $2. Phila.
P Eng...Practical Engineer. *w.* 10s. London.
Pl D .....Plumber and Decor. *m.* 6s. 6d. London.
Pr.......Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R P L....The Railway Press. *m.* 7s. London.
R R......Railway Review. *w.* $4. Chicago.
R W.....Railway World. *m.* 5s. London.
Ry T.. ..The Railway Times. £1. 5s. London.
S... .....Stone. *m.* $2. Chicago.
S A......Southern Architect. *m.* $2. Atlanta.
San......Sanitarian. *m.* $4. Brooklyn.
Sc.... ...Science. *w.* $5. Lancaster, Pa.
Sc A.....Scientific American. *w.* $3. New York.
Sc A S ...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
Sc Q.....Scientific Quarterly. *q.*. $2. Golden, Col
S E......Stationary Engineer. *m.* $1. Chicago.
S Ec ....Social Economist. *m.* $1.50. N. Y.
Sea......Seaboard. *w.* $2. New York.
S In......Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L......Steamship. *m* Leith, Scotland.
S M.....ScientificMachinist.*s-m.*$1.50. Cleveland,O.
S M Q....School of Mines Quarterly. $2. N. Y.
S R......Sanitary Record. *m.* 10s. London.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P......Sanitary Plumber. *s-m.* $2. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V......Safety Valve. *m.* $1. New York.
T........Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q......Technology Quarterly. $3. Boston.
Tr.......Transport. *w.* £1. 5s. London.
Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A...Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
W E......Western Electrician. *w.* $3. Chicago.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE & BUILDING

About Chimneys.

CHIMNEYS constitute an architectural and constructive problem, often not the least difficult of those which are encountered in the designing of new buildings. Were the points to be considered those pertaining only to artistic treatment, the subject would not be so difficult to deal with. The chimney, or chimneys, in such a case could be placed in the design where the best artistic effect demands, and the height above the roof could be adjusted to accord with the taste of the designer. But, as the chimney is a working device, its function being to pass a current of gases from the interior to the exterior of the building, regard must be paid to this function, and the location, size of flue, and height above roof must be considered with reference to that function. The same may be said regarding ventilating flues.

Mr. Fred. T. Hodson, in *Architecture and Building*, discusses the question at length, beginning with a historical sketch of the introduction of this feature of modern architecture, which he places near the beginning of the twelfth century, the first example known to history being in Rochester Castle, about the year 1130. In this building, also, as far as can be discovered, the first open fireplaces were used. "Italy claims that chimneys and fireplaces originated with her, though she has no tangible evidence to exhibit in proof of her claim; while in England many examples exist, dating from the twelfth century,—one, that in the great guard-room at Curisborough Castle, dating back as far as the early part of the eleventh century, bearing on its face evidences of having been erected during the Anglo-Saxon period; yet this fireplace has no chimney such as we know. In place of a chimney there is a flue or duct leading to the outside of the wall some twenty-five or thirty feet above the top of the fireplace. Doubtless it was this sort of a flue that led to the construction of the chimney as we now possess it, the flues being built in the walls, the thickness of which was ample to admit of pretty large ones. At first these flues terminated on the top of the wall and were topped off with hoods, arches, cowls, and other devices; but it was not long before medieval builders carried the flue a considerable distance above the walls. Then the architect's opportunity arrived, and he at once accentuated the projection, and made it an ornamental feature of the building to which it belonged; and to-day most of our best forms of chimneys are copies taken from the works of those old designers." In the United States the artistic treatment of chimneys has not received the attention given to this feature abroad, but of late years many fine examples of chimney architecture have been designed.

"The philosophy involved in the operation of a chimney depends altogether on the principle that a column of heated air is lighter than a cooler column of like dimensions. This being admitted, it follows that the lighter air will be forced upward by the heavier, just as a body lighter than water will be forced to the surface by the action of the heavier body. It is this action, caused by the difference of density, that establishes a current of draught. All other conditions being equal, the draught of a chimney is thus proportioned to its perpendicular height, and, of course, the difference in temperature within and without the flue. The straighter and taller the shaft, the more powerful will be the ascending current: but there are cases, no matter how straight or how lofty the chimney may be, that will refuse to conduct the smoke through its length under certain mysterious conditions. Some causes of chimneys smoking are well known and avoidable, the trouble arising perhaps from positive ill-construction, having a narrow part, an ugly bend, or a downward portion in their conduit, which their normal draught is not sufficient to overcome. Others smoke because they form the shortest channel by which the air can enter the house to supply the draught of a higher chimney. When there are two chimneys in one room, or in rooms adjacent to each other, and the doors and windows are closed in all other rooms, the shorter chimney will draught inwardly to supply the loftier one with a current. Sometimes the best constructed and most wisely designed chimney, with regard to the building in which it is situated, will smoke in consequence of its exit being in the immediate neighborhood of walls, hills, or trees, whose situation is such as to create at times strong eddies and cross-currents. In most cases, however, the addition of a few feet or so to the height of the chimney shaft, supposing it to be already above the ridge of the house which it ventilates, will prove more useful than any addition of those curiously contorted and usually non-pneumatic contrivances that are so often planted on the top of a smoky chimney to cure it of its 'cussedness.'"

Count Rumford is recalled as perhaps the chief of all chimney doctors. It is on record that he cured more than five hundred smoky chimneys where all previous attempts had failed. His system was to diligently search for, and remove, the local causes that obstruct draught, as he held that the very fact that the draught is defective is proof of the existence of such a cause either in the chimney itself, or in its immediate environment.

The design and construction of a factory chimney "require more architectural skill and scientific knowledge than most practitioners can lay claim to." As an assistance to designers, formulæ, and a table based upon these formulæ, are given, and practical questions, such as expansion, etc., are discussed, as are also care and inspection of chimneys.

Wind-Pressure on Buildings.

In the department of "Civil Engineering" in our February number, the subjects of tornadoes and wind-pressure exerted upon bridges and other structures were noticed, and the current technical literature of the month shows that the effect of wind-pressure is still claiming further and closer study. The London *Builder* has a leading editorial in its issue of February 2, which deals more particularly with the reduction of pressure on the leeward side of buildings as an element not included in time-honored formulæ, whose results are now regarded with more than suspicion in view of facts of comparatively recent occurrence. The first who called attention to the fact of reduction of pressure on the leeward side of structures subjected to the action of winds is said to have been Mr. Horatio Phillips, an experimenter whose work in this direction, the *Builder* thinks, has not received the recognition it deserves. "Since then, other investigators have pursued the subject. The latest addition to our knowledge on this question has been supplied by a Swedish experimenter, Mr. R. Irminger, who has recorded the results of his investigations in the form of a paper published in the *Ingenioren* of Copenhagen, and a translation of which may be found in the Library of the Institution of Civil Engineers. The experiments were made with models, and, though some correction might be necessary in applying the results to larger planes, yet the results clearly indicate that the question of wind on roofs requires reconsideration."

Mr. Irminger's method is substantially the same as that of Mr. Phillips, except in the manner of obtaining induced currents. Mr. Phillips used steam jets for this purpose. "Mr. Irminger has recourse to an opening in a tall chimney. In this was inserted a horizontal wooden tube 9 in. by 4½ in. in section. Experiments were made with inclined planes, spheres, cylinders, pyramids, and cones. The planes were each represented by two thick iron sheets placed one-tenth of an inch apart, and their edges connected all round, thus forming a shallow closed box. Holes were bored on both surfaces, and these could be plugged at will. The pivot on which the plane swung was a pipe leading to the interior of the box and having a pressure-gage on the end. In this way increase or reduction of pressure on either surface of the box-like plane could be ascertained. A plane 4½ in. by 1½ in. and occupying the full width of the tube was tried at various angles of inclination and with four velocities of air. When the plane was at an inclination of 5 degrees to the direction of the wind, the percentage of the total pressure which was produced on the leeward side of the plane was 100 at all velocities of wind tried, and the total wind-pressure was 23 per cent. of what it would have been had the plane been normal to the air current. By "pressure on the leeward side of the plane" is meant the pressure on the leeward sheet of iron. This pressure would naturally be in the direction of the wind, and would be caused by the reduction of atmospheric pressure on the opposite side, due to rarefaction. At an inclination of 10 degrees, with an air velocity of 49.5 ft. per second, the proportion of total pressure on the leeward side was 82 per cent., and at 31 ft. per second the pressure on the leeward side was 91 per cent. The proportion of total wind-pressure at this angle, as compared to the same area of normal plane, was 45 per cent. At 40 degrees inclination of the plane, and with a velocity of 49.5 ft. per second, 65 per cent. of the total pressure was due to the leeward side; at 31 ft. per second it was 70 per cent. The proportion of pressure as compared to the normal plane was 35 per cent. at this angle. At 90 degrees inclination of the plane, and 49.5 ft. per second of air current, the proportion of total wind-pressure due to the leeward side was 56 per cent.; at 31 ft. it was 59 per cent., and at this angle the total pressure was equal to that which would have been sustained had the plane been vertical or normal to the current. We have, for the sake of brevity, selected only a few typical instances contained in Mr. Irminger's tables, and the figures as to the proportion of pressure as compared to normal planes are averages of a larger number of experiments than we quote. The plane referred to, having its ends touching the sides of the box, may be considered as a plane of infinite length. Mr. Irminger tried a similar series of experiments with a plane 2 in. shorter,—viz., 2½ in. by ½ in. At 5 degrees inclination the results were very similar to those obtained with the larger plane at the same inclination, excepting that the proportion of total pressure as compared to the normal plane was but 12 per cent. At 10 degrees inclination also the whole of the total pressure was due to the leeward side, but the pressure was 26 per cent. of that due to a normal plane. At 40 degrees inclination and 49.5 ft. per second of air current, the proportion of total pressure due to the leeward side was 78 per cent.; at 31 ft. per second it was 74 per cent., and the proportion of total pressure compared to the normal was 74 per cent. At 90 degrees inclination, it was 49.5 per cent. of the whole; at 31 ft. per second it was 40 per cent. of the whole. The total pressure at this angle, as with the other plane, was equal to that of a normal plane."

Probably some will object to these experiments that the conditions under which the results were obtained by Mr. Irminger are not yet demonstrably the same as those under which buildings are subjected to strains in gales of wind; but, even admitting the validity of this objection, the experiments clearly prove that a change of pressure-conditions does occur on the leeward side of the plane when a current of air impinges against the opposite side, and also that the reduction is a notable percentage of the force with which the wind acts on a resisting or a deflecting surface.

The experiments were extended to cubes and prisms. A cube with the wind striking it parallel to the edge showed a total resultant pressure in the direction of the wind of 0.80 of total pressure on a disk equal to the face, the percentage due to rarefaction being 22 per cent.; with the wind parallel to the diagonal of the face, the pressure was 0.66. A cylinder of a height equal to its diameter received a pressure of 0.47 of that which would have been exerted on a square disk equal to a section through the axis, the rarefaction ratio being 50. A pyramid of square base, with a side equal to the height, gave, with the wind parallel to the side of the base, a pressure of 0.78 of that which would have been exerted upon a disk equal to a maximum section perpendicular to the wind; with the wind diagonal to the base, the corresponding percentage was 55. In the former instance the rarefaction was 37 per cent. Lastly, with a cone in which the height equalled the diameter of the base, the resultant pressure was 0.38 of that due to a disk equal to the maximum section perpendicular to the wind, 50 per cent. of the total pressure being due to rarefaction.

Experiments with analogous results were also made with models representing buildings of different forms. Some of the effects upon roofs are peculiar; for instance, with a roof of 45 degrees pitch, the wind blowing at right angles, the part on the lee side was subjected to an upward resultant pressure of more than three times the "actual wind pressure on the windward side," and on the windward side the pressure diminished uniformly from the lower edge to the ridge, where it became *nil*. Now, these experiments indicate either that the experiments themselves are unreliable, or that there are mysteries in the action of winds that challenge immediate and thorough investigation by a number of experimenters sufficient to clear up all remaining doubts upon the subject.

Velocity and Pressure of Wind.

THE above remarks may be fitly followed by a review of some notes on the effects of wind upon structures in Quebec during the storm that visited that city December 28, given in *The Canadian Engineer* for February by Mr. Charles Baillairge. Several chimneys 80 to 120 ft. high were blown down, and the roof of the westernmost kiosk of Dufferin Terrace "was bodily wrenched from its understructure of cast-iron columns, girders, supporting brackets, spandril pieces, etc., and blown to a distance of 100 ft. or more and half way up the cliff intervening between the terrace, which is at 180 ft. above river level, and the citadel at about double that elevation." What this latter feat really signifies is well brought out by a calculation made by Mr. Baillairge, who estimates the weight of the roof, in detail, "at some 2½ tons, including cast-iron rafters, iron purlins, galvanized sheet-iron covering, wrought-iron tie-rods, and the like. Taking the resistance of ordinary bar iron at only 25,000 lbs. to the sq. in., or 12½ tons, and, as the roof was held in place by light wrought-iron screw bolts and nuts of ⅝ inch diameter, to break each of which a strain of 3⅛ tons must have been exerted together, including weight of roof (some 27½ tons), the area acted on by the wind being say 640 ft., the conclusion is arrived at that a force of not less than 86 lbs. must have been brought to bear per sq. ft. of area to produce the effect recorded; and, if the pressure be assumed to increase as the square of the velocity, this velocity at that particular point or portion of the terrace must have been 130 miles an hour."

The anemometer at the Quebec Observatory is said to have broken down after recording a velocity of 90 miles per hour, but the wind evidently increased in velocity after the anemometer ceased to register. Mr. Baillairge expresses the view that, "while the general velocity of the wind may not have exceeded from 80 to 100 miles, there may have been within the general current a local one of greater speed, as with the Gulf Stream flowing from the Gulf of Mexico into and across the Atlantic ocean Or the increased velocity and force at that particular point may have been and was likely due to some cyclonic or gyratory action, as often observed in cyclones, such as we have all been witness to when, on a windy day and while the air in motion along a street takes the dust with it and thus becomes visible to the senses, a tiny cyclonic action may be observed here and there, where streams of wind rotate as they advance with the general current in which their motion forward or of translation is involved. Another argument favoring this conclusion is that along the 1,500 ft. of terrace, every portion of which is equally exposed to the fury of the wind, there are four other kiosks of exactly the same construction as the one unroofed by the storm; and, while one of these suffered only to the extent of having a small portion of the roof sheathing torn and blown away, the others stood the fury of the gale unscathed." The tall buildings now standing and going up, if subjected to such wind-pressures as this, would have their strength tried to a limit that certainly would be ground for anxiety.

Slate and Tile Roofs.

A CONTRIBUTOR to the *Pall Mall Gazette*, quoted in *The Illustrated Carpenter and Builder* (London, Feb. 1), describes the slate and tile roofs in various parts of England. The Cumberland slate is considered as one of the most beautiful roofing materials known, on account of its "exquisite greenish-gray color, with silvery reflections and glaucous bloom. The purple Welsh slates make roofs that, according to this pleasant writer, are simply hideous compared with those of Westmoreland and the older roofing slates, but their great durability is nevertheless bringing them into favor.

"The train has halted at Hawes Junction, and it is evident that the invader has gained a footing even in the heart of the dale. All round for miles, dotted on the grassy slopes, may be seen the grim gray garths and haybarns of the 'statesmen' and farmers, with stone roofs deeply stained with olive and russet and splashed with golden lichen. But the harmony is shattered by spick-and-span railway buildings, smugly hatted with purple Welsh slates; and even in the villages it is plain that the old fashion is falling out of favor, for all the new dwellings and the meeting-houses are roofed with Welsh slate. Time, the great redresser of wrongs and veiler of blemishes, is almost powerless to help matters. The close crystalline texture of these slates enables them to resist all kindly vegetable pigment. It is true that sometimes, near the sea, a salt crust is deposited, giving foothold to an orange lichen, which creeps over the surface with charming effect; but generally the tone remains unchanged, and rarely is a roof now put on with liberal eaves. The worst of it is that there is no remedy, for not only is the new material provokingly excellent for resisting wind and weather, and very clean, but it is ridiculously cheap, and requires much less weight of timber to support it than tiles, stone, or the heavier slate of Cumberland."

The effect is described as even worse in Scotland, where trees are scarce and do not hide the blemish. The Annansdale and Nithsdale village roofs of red sandstone flags that afforded a fine contrast with the gray stone walls are being replaced with the purple Welsh slate, very much derogating from the picturesqueness of Scottish villages. The same is true of tile roofs. "Few people are aware how much tile roofs were in use in Scotland from early times, and how greatly the scenery has suffered from their disuse. Those square border keeps which are such familiar objects in the lowland landscape once had a very different appearance. There is preserved in the British Museum (Cottonian collection, 'Titus,' c. xli, folio 76–87) a report on the military strength of the Western Marches by an English officer in 1563-66. This is illustrated by water-color drawings of the chief strongholds and some of the towns in Dumfriesshire and Galloway. All the castles, except Annan, and all the houses in the towns, are shown with steep red roofs,—that is, roofs of tile. The churches have gray roofs of stone, and the tower of Annan has a blue roof, apparently meant for lead. Now, it may seem a small matter to complain of, that, in a few years, English villages and Highland shielings will be uniformly sheeted with changeless mauve slate, and the complaint, as has been admitted, is a futile moan. But would the injury be reckoned a light one if some day the eye of one standing on the roof of the Duomo of Milan were to rest, not, as now, on countless housetops of heavy red tiles, but on an unbroken expanse of smooth metallic purple?"

Weathering of Building Stones.

A PAPER upon this subject, read by Prof. Coleman, of the School of Practical Science, Toronto, before the Ontario Association of Architects at its fifth annual convention, and printed in the *Canadian Architect and Builder*, contains points relating to the effects of atmospheric influences upon building stone that will be new to most lay readers. The expansion of stone near the surface when the sun shines strongly upon it in cold weather is one of the agencies by which destruction is gradually brought about. Stone being a poor conductor of heat, a thin stratum on the outside is expanded by solar heat before the inside is heated, and strains are thus generated which tend to cause scaling of the surface, or, perhaps more accurately, prepare the stone for the more powerful action of frost. The minute pressures caused by expansion admit water. This, subsequently freezing, expands with great force, and thus portions of the stone are flaked off. Another effect of temperature is the contraction in cold weather of mortar joints that have been laid in warm weather. This tends to produce fissures that "admit water and make the starting-point for other changes. As a general rule, stone absorbing 10 per cent. crumbles rapidly in our (Canada) winters, and should not be employed where carving or fine finish of any kind is exposed to the weather."

As to the chemical action to which stone is subjected in different climates, Prof. Coleman says: "Rain water is more or less strongly charged with oxygen, carbonic acid, and other substances found in the air. The nitrogen of the air is inert, and the oxygen and other substances are active only in the presence of water, so that very dry air has little or no effect in weathering. In very dry climates, like that of Egypt, monuments of stone may be ground off by driving desert-sand acting as a sand-blast, but are scarcely affected in other respects after 4000 or 6000 years' exposure to the weather. How differently a damp climate affects the stone may be seen only too well in the Egyptian obelisks transported to London, Paris, and New York. It is well known that in the last-named city the granite scaled so rapidly that the obelisk had to be coated with paraffine to preserve it at all."

There is, however, one chemical change that stone undergoes which is welcomed by architects and all lovers of the beautiful and picturesque. This is the change of color produced chiefly by low oxidation: "This may be called the mellowing touch of time as contrasted with the gnawing tooth, and from the artistic side an architect's work, like a rich wine, may ripen and improve with years. On the other hand, there are color changes produced by other reagents than oxygen,—notably sulphur—that may greatly disfigure buildings. Certain sulphids, especially the brassy yellow mineral pyrites, are changed by oxygen in the presence of moisture into sulphates, and finally into oxids. Granites, marbles, and other crystalline rocks are stained an ugly brown by the hydrous oxid formed, so as to be quite disfigured. This change is less important in the sandstones, though even then the change of color may be disagreeable. Many stones used in the Parliament Building at Ottawa illustrate this, the dark brown smear having sometimes run down onto the blocks below. Stones rich in magnetite, such as diabase, sometimes used as black granite, may be acted on in a different way. The mineral magnetite consists of the sesquioxid of iron combined with the monoxid. The latter portion may weather into hydrous sesquioxid, giving brown stains, and sometimes causing the rock to crumble. The color schemes of buildings should always be considered with reference to the changes which atmospheric influences will effect, and also with reference to the custom prevailing in the environment, in the matter of the use of fuel,—hard or soft coal, etc.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*29148. Recent Architecture in France. Ill. Barr Ferree (E Mag–April.) 4000 w.

†29154. Padauk. Editorial (I Eng–Jan. 5.) 1500 w.

29184. Church of All Saints, God's Hill. Ill. (A A–Feb. 9.) 3000 w.

*29188. E. G. Paley's Churches. Ill. (A L–Feb. 1.) 2700 w.

*29199. Wind Pressure on Buildings—Experiments of R. Irminger (B–Feb. 2.) 1800 w.

*29201. The Legal Position of Architects in Relation to Certificates and Awards. J. A. Strahan, with Discussion (B–Feb. 2.) 6000 w.

*29202. Tynemouth Priory. Ill. E. R. T. (B–Feb 2.) 2400 w.

*29211. Styleless Architecture. Anon. (A B D–Dec.) 2000 w.

*29237. Faults in Outside Painting. A. Ashmun Kelly (I C B–Feb. 1.) 700 w.

*29238. Slate and Tile Roofs. Anon. (I C B–Feb. 1.) 1200 w.

*29240. American Mantels. Ill. Anon. (I C B–Feb 1.) 1000 w.

*29242. Building Stone. Anon. (I C B–Feb 1.) 1100 w.

29249. Velocity and Pressure of the Wind—Notes on the Storm of Dec. 28th at Quebec. Charles Baillairge (C Eng–Feb.) 750 w.

*29254. Notes upon Testing Building Stones. F. Lynwood Garrison. Read before Amer. Soc. of Civ. Eng. (S–Feb.) 3500 w.

*29256. The Granites of Scotland. (Extract.) Hjalmar Lundbohm (S–Feb.) 4200 w.

29307. Recent Experiments on Wind Pressure—Abstracted from "Ingenioeren" by O. J. Marstrand (E N–Feb. 14.) 2200 w.

*29337. Borders and Bands. Ill. H. Leslie Ramsey (Pl D–Feb.) 1200 w.

*29338. A Chat on Mural Decoration. W. N. Brown (Pl D–Feb.) 1000 w.

*29404. Hints for Churches in Hot Climates. Anon. (B–Feb. 9.) 2800 w.

*29406. Architectural Perspective. Ill. W. S. Weatherley, with Discussion (B–Feb. 9.) 8000 w.

*29455. Exigencies of Commercial Buildings—From the Building News (I C B–Feb. 8.) 1300 w.

*29476. Noyon Cathedral. Anon. (A L–Feb. 8.) 1800 w.

29512. Cements. H. F. Bryant (M & B–Nov.) 700 w.

29514. The Influences Against the McKaig Bill. John M. Carrère (A A–Feb. 23.) 2500 w.

29549. Stamp Sand in Cement Mortar. Edward Kidwell (E M J–Feb. 23.) 400 w.

*29580. Shearing Tests of Mortar. Cecil B. Smith (B B–Feb.) 700 w.

*29584. Portland Cement—A Plea for a Greater Uniformity in the Tests and Specifications. C. H. C. Wright (Can A–Feb.) 3000 w.

*29585. Electricity for Architects. John Langton (Can A–Feb.) 3600 w.

*29586. The Weathering of Building Stone. Professor Coleman (Can A–Feb.) 2200 w.

*29604. The History of Architectural Drawing. Anon. (I C B–Feb. 15.) 800 w.

*29605. Isometric Projection. H. A. Caxton Jay and A. Robinson (I C B–Feb. 15.) 900 w.

*29607. The Study of Old Buildings. Anon. (I C B–Feb. 15.) 1100 w.

*29610. The Ancient Cambodian or Khmer Monuments in Eastern Siam. Ill. Anon. (B–Feb. 16.) 3000 w.

29760. A Travelling Scaffold for Painting the Roof of a London Train-Shed. C. H. G. (A A–March 2.) 900 w.

*29845. The Roman Fort at Saalburg. Ill. Anon. (B–Feb. 23.) 2500 w.

29924.—$1.50. The Strength and Weathering Qualities of Roofing Slates. Ill. Mansfield Merriman, with Discussion (T C E–Dec.) 3500 w.

Serials.

12568. Building Construction and Superintendence. F. E. Kidder (A & B–Began May 6, 1893—40 parts to date—15 cts. each).

18857. Electrical Science for Architects. Ill. Russell Robb (A A–Began Jan. 13, 1894—8 parts to date—15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (B B–Began Jan., 1894—14 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (Pl D–Began March, 1894—11 parts to date—30 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (B B–Began April, 1894—10 parts to date—30 cts. each).

26070. The Planning and Construction of American Theatres. Ill. William H. Birkmire (A & B–Began Oct. 13—5 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. W. J. Eden Crane (I C B–Began Nov. 9—6 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (A & B–Began Nov. 24—4 parts to date—15 cts. each).

28494. Bricks and Terra Cotta (B–Began Jan. 5—7 parts to date—30 cts. each).

28582. Architecture in India. N. N. Waslekar (I A–Began Jan.—2 parts to date—45 cts. each).

28805. Fireproof Floor Arches. Ill. George Hill (B B–Began Jan.—2 parts to date—30 cts. each).

29200. The Advancement of Architecture. Professor Aitchison (B–Began Feb. 2—4 parts to date—30 cts. each).

29253. The Guilds of the Medieval Workers in Stone. Edward C. Weaver (S–Began Feb.—1 part to date—30 cts).

29327. The Use of Steel in Large Buildings. (Abstract.) Corydon T. Purdy. Read before the Boston Soc. of Civ. Eng. (E R–Began Feb. 16—2 parts to date—15 cts. each).

29358. Hints to Art Students in Travelling Abroad. J. W. Case (A A–Began Feb. 16—3 parts to date—15 cts. each).

29578. On the Use of Brick in Domestic Architecture. Ill. Ralph Adams Cram (B B–Began Feb.—1 part to date—30 cts).

29581. Ornamental Brick Arches. Ill. Archie (B B–Began Feb.—1 part to date—30 cts).

29582. On Observation. Leonard Stokes (B A–Began Feb. 15—Ended Feb. 22—2 parts—30 cts. each).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

Recent Work of the Massachusetts Highway Commission.

"ALL friends of the good-highway agitation in the United States," says *The Engineering Record* (Feb. 23), have been following with much interest the work of the Massachusetts Highway Commission, composed of Mr. George A. Perkins, a lawyer of Boston, Prof. N. S. Shaler, of Harvard University, and Mr. W. E. McClintock, M. Am. Soc. C. E., of the engineering firm of McClintock & Woodfall, Boston.

The method of proceeding followed by city officials or selectmen of towns when they wish to place an old or new road under the charge of the State is to make application to the commission in proper form, and file a plan of the road. "In case the commission believes that the highway should come under the control of the State, it files a plan of it in the office of the commissioners of the county in which the petitioners reside. With this plan is filed a copy of the petition, and a certificate that it has laid out and taken charge of the road. The commission also files a copy of the plan of the portion lying in each city or town with the clerk of the city or town. When this is done, the road becomes a State highway, and the commonwealth is responsible for the construction and maintenance, no openings or obstructions being allowed along its length except with the permission of the commission.

"When ready to begin actual work on the road, the commission gives to each city and town in which the highway lies a certified copy of the plans and specifications. The city or town then has the right, without advertisement, to contract with the commission for building so much of the highway as lies within its limits, the work to be done under the supervision of the commission and subject to its approval. If the local authorities do not care to do this, then, after the lapse of 30 days, the commissioners advertise in at least two papers published in the county where the road is located, and in three or more Boston daily papers, for bids for the construction. The selection of roads for State control is required to be 'fairly apportioned' among the different counties, and not more than 10 miles may be constructed on petition in any 1 year in any one county without the previous written approval of the governor and council. For maintaining the State highways the commission is authorized to contract with the cities and towns in which they lie, or with private parties. One of the unusual features of the act is a clause requiring the commission to keep the roads reasonably clear of brush, to plant shade trees along them, and to establish and maintain watering-troughs at suitable places."

The public jurisdiction of cities and towns over roads thus constructed is stated with its scope and limitations, and the clause of the act providing for cost of construction and repairs follows. The act not having gone into force until June, 1894, it is stated that operations have not advanced as they would have done could work have commenced in the spring. The difficulty of convincing local authorities that they could construct such roads as the act contemplates "was overcome when it was found that a competent man would be stationed on each road where work was in progress, and that the State would make payment at so much per ton for stone, so much per yard for earth and rock excavation, so much for each foot of drain, and at a definite price per unit for all other items. The authorities knew that the State's representative would see that good work was done, and felt that what they accomplished would be accepted. Up to the close of last year thirty-six contracts were accepted, and work was commenced in twenty seven towns. The construction is carried on under the direction of a chief engineer, Mr. Charles Mills, and a resident engineer on each piece of work. The resident engineer puts in the line and grade-stakes, and keeps a force account and a record of all work done and material used, making a daily and weekly report to the commission, and a monthly summary of everything accomplished to date. The local authorities are represented by their superintendent of streets, road commismissioners, or a competent man appointed as foreman." A copy of the blank forms used in reports, and of the general specifications for the roads, with other general information relating to materials and work, render this an instructive article on road-making.

Anchor-Ice.

THE clogging of gates, wheels, etc., with anchor-ice annually causes serious embarrassment in many parts of the United States and Canada and, indeed, in all cold climates where hydraulic engineering is conducted. Chicago has several times had its water supply thus threatened. At a recent meeting of the American Society of Civil Engineers the subject was brought up for discussion, and remarks offered by various engineers were published in *The Engineering Record* (Feb. 16). The consensus of opinion was that anchor-ice forms through the concreting of minute acicular crystals? Any current tending toward any particular point carries the crystals along. If any solid object be presented to the current against which the crystals impinge, they not only adhere to this object, but immediately stick together, forming a growing mass. This conglomeration of ice-crystals is explained by Tyndall in his famous treatise, "Heat as a Mode of Motion," in the discussion of the phenomenon of regelation. Nearly all who took part in this discussion related interesting experiences with anchor-ice.

Mr. William E. Worthen said he had had a little experience with anchor-ice in the course of his practice. He found that it forms in acicular needles which shoot across the surface of water. If the water is still, the crystals come together to form a solid sheet; but, if there is a ripple on the water, the crystals are broken up, mix with the water in the form of slush, and attach themselves readily to rock, iron, or other material with which they are brought in contact. The same breaking-up of crystals has been noticed with saltpeter in the manufacture of gunpowder. For many years Mr. Worthen lived within a quarter of a mile of the lower falls at Lowell, and he could always tell when anchor-ice was forming. As it formed, the noise of running water ceased, and he found that at such times the weather was sharp and cold, with light breeze.

An account of a large accumulation of anchor-ice on piles driven for the foundation of the Wisconsin river bridge was given by Mr. J. F. O. Rourke. The butts of these piles were covered with ice from top to bottom. The piles being driven in weather 20° below zero, the coldness of the timber was supposed to account for the phenomenon,—an explanation wholly inadequate, we think.

Mr. Desmond Fitzgerald agreed with Mr. Worthen. "If there are winds blowing that keep water in motion, it may not freeze over till the whole body of water is cooled to the freezing-point." This is the condition for formation of anchor-ice, and Mr. Fitzgerald added that at Brookline, Mass., this usually takes place at about Christmas time each year.

Mr. T. C. Reefer said that anchor-ice will run under the frozen ice surface of the St. Lawrence from 10 to 12 miles, and that this is a common occurrence in the St. Lawrence; in fact, at the beginning of winter it [anchor-ice] passes through the whole length of the river before the latter becomes frozen over. He now keeps the run of the temperature of the water, and, if he finds that the whole mass is down to about 32°, while the surface is unfrozen, men are stationed in the gate-houses to watch for anchor-ice. It will form in a very short time after these conditions have been reached. This ice, so far as he has observed, is in the form of needles and thin scales about the size of a half-dollar. It apparently comes in with the current from all parts of the body of water, and has a way of collecting in punky masses which soon fill up all openings. In the principal gate-house under his charge there is a steam pipe laid, reaching into the water in front of the screens, so that steam can be blown down into the masses of ice to break them up. At the ice bridge, which first forms below Montreal, the floating anchor-ice is carried under the surface of the bridge ice, and accumulates until sometimes it hangs down 50 ft. from the underside, like a gigantic wasp's nest. He has found it to extend 90 ft. below the surface at the head of Lake St. Louis and at the foot of a long rapid. The explanation offered for the starting of the ice on the bottom is as follows: At first the whole surface of the St. Lawrence river is covered with sludge ice,—an aggregation of crystalized needles broken up by winds and currents and drawn together into little masses. The sludge ice passes down until the water gets cold enough to bridge the river over, the bridge forming where the current is checked. The anchor-ice glides along under the bridge, until stopped by friction or other causes, and then it freezes fast and grows downward. When the descending ice has been elbowed by the current into all the side channels, and the main current is confined into one central stream, the anchor-ice is carried down until stopped by the surface ice. In this way an inverted dam is gradually formed, which causes the river to back up until its winter level is 10 to 15 ft. above that of summer, and the wharves of Montreal are covered.

We can quote further only one interesting experience related by Mr. John R. Freeman, relating to the obstruction by anchor-ice of a hoisting turbine at the Northern canal, in Lowell, some years ago. "In the early morning, just before starting-time for the mills, the turbine speed-gate was raised so that the main sluice-gates might be opened. The turbine immediately became plugged up with interlacing needles of anchor-ice, and would not move. Thousands of operatives were waiting to begin work, and tradition states that things were in a terrible condition around that gate-house for 2 or 3 hours. Just as other means had been improvised, the sun rose high enough for its rays to fall on the water in front of the feeder to the turbine, which resulted in the starting of the latter in a short time." Here it is seen that the slight warming of the water due to the sun's rays was sufficient to make the ice let go. The fact seems to substantiate the theory that anchor-ice forms at the freezing-point of water, and that the water does not fall below the freezing-point, as Mr. Keefer asserted that it sometimes does when anchor-ice forms.

Deep-Water Route from Lakes to Ocean.

CAPTAIN D. C. KINGMAN, United States Corps of Engineers, has contributed to the *Journal of the Military Service Institution* a long and able paper upon this subject, which can only be outlined in this department. Though the military arguments for a deep water-way are briefly re-stated, Captain Kingman has appropriately entitled his paper "Engineering Aspect of a Deep-Water Route from the Great Lakes to the Ocean," the paper dealing mainly with this aspect. The proposition that "any public work which tends to put us upon an equality with Great Britain in our future ability to defend our side of the great lakes cannot fail to be a work of great importance to the common defence hardly admits of dispute, or scarcely needs any argument to support it. A deep waterway through the United States territory will admittedly effect this result. The engineering problem comprises the selection of the most feasible route, and the best and most economical construction, considered not only with reference to first cost, but also with reference to cost of maintenance and to the facilities afforded for traffic to large vessels between the seaboard and the North American inland waters."

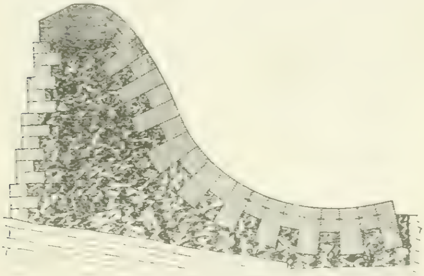
The attempts which have been made to connect the North American lake system with western rivers in a manner which would continue the water route to the sea are classified into those which "have simply resulted in the formulation of projects," those in which "the work proposed has been accomplished," and those in which "the work of construction is now in progress." Of these the following are named: "(1) A proposed route by canal from Duluth to the Mississippi river near St. Paul. (2) The Fox and Wisconsin route by river and canal from Green Bay to Prairie Du Chien,— once actually opened, but now practically abandoned as a through route. (3) The Illinois and Mississippi canal, now under construction, which is designed to furnish a navigable water-way, seven feet deep, from Chicago on Lake Michigan to the Mississippi river near Rock Island. (4) The Illinois and Michigan canal, originally constructed by the State of Illinois, which, with the Illinois river, forms a water route from the southern end of Lake Michigan to the Mississippi at Grafton. It afforded a 6-foot navigation for vessels of not over 18-foot beam. The works now in progress by the United States, in connection with those of the city of Chicago, will ultimately make this a navigable route for the largest class of steamboats that are in use upon the river.

"Then there is the Wabash and the Erie canal, which connected Lake Erie at Toledo through the Wabash river with the Ohio. Like most of the older canals, it was designed for a special class of small boats. Finally, there may be mentioned a project now under consideration to connect Lake Erie by canal with the Ohio river near Pittsburgh. There may be others, but I have mentioned enough to show that the subject has been pretty thoroughly considered, and that it is highly improbable that there now remains undiscovered any particularly available canal-route between the lakes and the river."

In view of the objects aimed at in the improvements of the Ohio and the upper Mississippi, Capt. Kingman asserts that "these rivers can never become available for such ships as now navigate the lakes and the Ocean"; and he gives strong reasons for this opinion, not the least of which is that "owners of valuable and expensive ocean vessels would certainly hesitate to send them on long river voyages into the heart of the country, with a reasonable probability of their being caught by the falling water and so stranded and perhaps destroyed with their valuable cargoes, or at best held helpless prisoners for weeks or months, until released by the succeeding high-water." The conclusion is regarded as irresistible that a deep water-way by way of the Mississippi is a commercially impracticable scheme. By far the most practicable route, from the water-way through the great lakes now under construction, is to continue this from Buffalo, to and through the Hudson river via the Niagara river and Lake Ontario, going down by a series of locks from Niagara Falls,—from Lake Ontario through the Oswego river to the mouth of the Oneida river, thence to and through Oneida lake, thence over the divide to the Mohawk near Rome, and thence down the Mohawk to the Hudson. The Erie canal from Buffalo is disapproved entirely on engineering grounds, one of the principal being the proposition that "a ship canal ought to be all in excavation." Substantial arguments for this fundamental proposition are given, and from this as a basis a complete scheme of engineering for the construction of a deep water-way over the route proposed is elaborated.

New Dam at Holyoke.

An illustrated description of the large dam about to be built across the Connecticut River at Holyoke, Mass., is given in the *Railroad Gazette* (March 8) from which the following particulars are abstracted: "The work will consist of a masonry dam 1020 ft. long and about 30 ft. high, exclusive of that portion situated in the pool below the present timber dam. The base will be about 54 ft. wide. The upper course of masonry to a depth of 5 ft. below the crest and the whole outward facing of the dam will be built of first-class granite dimension stone, as shown in the engraving, and of varying lengths, so as to properly bond on the courses below. None of the uppermost stones are to be less than 4 ft. long. Each stone is to be dowelled to the stones below by dowels made of galvanized round iron 1½ in. in diameter and 16 in. long. The stones are to be laid in full cement mortar, and all beds and joints are to be dressed for the full depth of the stone. No joints will exceed ¼ of an inch in thickness. The cement used will be Portland cement, and the mortar will be a mixture of one part of cement and two parts of sand. The concrete used will be broken stone and mortar, five parts of broken stone not over 2 in. diameter to one part of cement in the mortar used. The facing stones, from the upper courses above described to the foot of the curved surface, are to be of similar granite to the upper courses, and will be laid in regular courses composed of two stretchers and one header alternately, except the lower course, which will be all headers. These stones will be about 6 ft. 8 in. long, 3 ft. 4 in. wide, and 2 ft. 6 in. high. Rubble stone masonry without regular courses is to be used for the interior portion of the dam and abutments, as shown in the engraving. The back of the dam is to be built of split granite laid in horizontal courses with joints not exceeding ½ in. in thickness. One-fifth of this face is to be headers 4 ft. long. The outer face of the southern abutment and wing wall will consist of rock face granite dimension stone laid in horizontal courses, the rise of each course to be the same as those of the existing abutment of which it is a continuation. There will be at least one header for every 10 ft. in length of stretchers. The inner side of the southern abutment and wing wall will be faced with masonry similar to that used upon the outer side. The two upper courses will be of dimension stone. The uppermost, which is the coping course, will be of large stone. The interior of the abutment, the space covered by the section of the dam and the inner wall above the [dam and up to within 17 ft. of the top, will be built of masonry similar to the interior of the dam—that is, rubble masonry, which, however, will be laid in courses, with parallel beds, instead of without courses. The northern abutment, the waste way, and the river wall are to be built of masonry similar to that of the southern abutment. On the top of the waste way a course of stone 40 ft. in length, 4 ft. in width, and 2 ft. in depth will be required. The wing walls descend from top to bottom in steps varying in depth according to the different courses. Each step will be coped with a granite block 6 ft. long.



NEW DAM AT HOLYOKE. SECTION.

"There will be used in the dam about 34,500 cu. yds. of rubble masonry, 1825 cu. yds. of granite in the upper courses, 7000 cu. yds. of granite dimension masonry in the face of the dam, 2500 cu. yards of split granite in the back of the dam, 2300 cu. yds. granite dimension masonry in the abutments and wing walls."

Lift Bridge at Milwaukee.

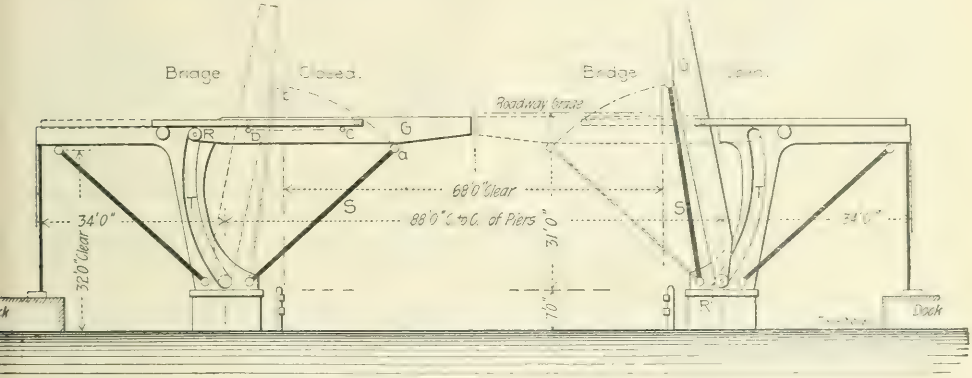
A VERY ingeniously contrived bridge invented by Mr. Max G. Schinke, assistant city engineer, Milwaukee, is described in *Engineering News* (March 7) by Mr. John Geist, chief engineer of the Wisconsin Bridge and Iron Company, and designer of the bridge under notice. The principle of construction is shown in the accompanying diagram, to which our contemporary has added a half-page engraving of the completed bridge and a two page inset of details illustrating all the features of the design. The bridge was designed for use at the Sixteenth street viaduct, Milwaukee. The reasons for the adoption of this kind of bridge follow:

"The Sixteenth street viaduct, recently completed at Milwaukee, Wis., is a structure 60 ft. wide and 4000 ft. long, connecting two densely populated portions of the city of Milwaukee, Wis., and crossing the North Menominee canal at an elevation of 38 ft. above water-line. In designing this structure it became necessary to provide for opening 68 ft. in the clear at the canal to permit the passage of large vessels to and from the coal yards and other establishments located in the neighborhood.

"Dock property being very valuable on both sides of the canal, it was out of the question to use an ordinary swing bridge, even if constructed with unequal arms, since it would prevent vessels from mooring close to the bridge, and would otherwise obstruct the channel, which at this point is quite narrow. It was also thought advisable to locate the opening as near the middle of the stream as possible." Referring now to the diagram, the mechanical features of the bridge may be said to consist of main girders *G*, upon which the roadway floor is supported, swinging struts *S*, each hinged to the girders at one end while the opposite end is hinged or pivoted to the base of the corresponding upright resting on the pier, and rollers *R*, attached to the ends of the girders opposite the ends near which the swinging struts are connected with the main girders, these rollers bearing upon and working in curved tracks *T*. Obviously, when the inner end of either part of the bridge is lifted, its rollers will go to the bottom of the track; and the reverse when the same end is again lowered to its normal position. The arrangement is ingenious, and seems well adapted to situations like that described. Its advantages are summed up by Mr. Geist as follows: "(1) It permits a floor of the heaviest kind, with paving, or of asphalt and concrete on buckle plates, without making the bridge too dangerous to operate, since there is perfect balance of the moving portion at all times and seasons. (2) On account of the peculiar motion of the swinging portion, the effects of wind forces are much reduced, and can be easily controlled. (3) The central deflection is small, due to the supporting swinging struts. (4) Both ends of streets or approaches are closed by the bridge floor when the bridge is opened. (5) It requires no center pier, and permits a single wide channel for vessels. (6) This construction requires no towers projecting above the roadway and obstructing the view of the river."

Irrigation in Pecos Valley.

According to an article in *The Railway Age* (March 1), one of the most extensive schemes now being worked out in the arid regions of the United States is that of the Pecos Irrigation and Improvement Company and other associated corporations in Pecos valley in southeastern New Mexico.



LIFT BRIDGE AT MILWAUKEE, WIS.

"The undertaking is a stupendous one, contemplating as it does the reclamation and settlement of a veritable empire,—a valley 165 miles in length. To accomplish this a system of irrigating canals with an aggregate length of 1200 miles has been built, together with a series of reservoirs impounding 6,300,000,000 cu. ft. of water. One of the reservoirs of this series is the largest in America, and is exceeded in size only by the Periar reservoir in India. At least 400,000 acres of land will be reclaimed, and ten thousand families will be provided with homes and the chance to secure a competence. Seventy-five thousand acres have already been settled upon in the valley, and the settlers are profitably engaged in raising standard crops, particularly alfalfa, which grows in utmost luxuriance, together with fruits which are disputing preëminence with those grown in the most favored sections of the country. Very satisfactory progress is being made at the present time in the valley's settlement, the fertile lands being rapidly taken—in the main by a good class of farmers and fruit-growers, principally from the middle west. The valley, which six years ago was an unbroken, barren plain, practically uninhabited, is to-day dotted with farms; while towns and villages are springing up in many places in which the foundations of prosperous communities are being laid. The Pecos valley is also expected to become one of the most prominent sanitarium centers of the Rocky mountain region, as it combines preëminently favorable climatic conditions with opportunities for profitable occupation."

An important work in connection with the great reclamation scheme of irrigation is the extension of the Pecos Valley Railway from Roswell, its present northern terminus, on to Washburn.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Bridges.

29361. London Bridge. Anon. (A A–Feb. 16.) 2200 w.

29492. A New Bridge Over the East River at Blackwell's Island, New York. Ill. (Sc A–Feb. 23.) 700 w.

29681. The Tolbiac Street Bridge at Paris. Ill. (Sc A S–March 2.) 900 w.

*29847. London Bridges, Architecturally Considered. Ill. H. H. Statham, with Discussion (B–Feb. 23.) 14000 w.

29887. Suspension Bridge Over the Hudson River at New York (Ir Age–March 7.) 1300 w.

29927. The Lift Bridge of the Sixteenth Street Viaduct, Milwaukee, Wis. Ill. John Geist (E N–March 7.) 1300 w.

29935. The Hudson River Bridge Specifications (R G–March 8.) 4500 w.

Canals, Rivers and Harbors.

29219. Another Ship Canal Project. Editorial (R A–Feb. 8.) 500 w.

†29228. Engineering Aspect of a Deep Water Route from the Great Lakes to the Ocean. D. C. Kingman (J M S I–March.) 9000 w.

29303. The Illinois and Mississippi Canal Lock Works. Ill. (E N–Feb. 14.) 4400 w.

29326. A Discussion on Anchor Ice. Remarks made in the Discussion of John R. Freeman's Paper (E R–Feb. 16.) 1500 w.

†29490. Canal Towage in France. Anon. (I Eng–Jan. 19.) 2800 w.

29569. The Stability of Crib Breakwaters.—From the Annual Report of James F. Gregory (E R–Feb. 23.) 1800 w.

29682. To Improve New York's Canals (Sea–Feb. 28.) 2200 w.

29698. Ship-Canal Projects at Seattle, Wash. Eugene Ricksecker (E N–Feb. 28.) 800 w.

29922.—$1.50. Improvement of Gray's Harbor, Wash. Ill. Bolton W. De Courcy, with Discussion (T C E–Dec.) 5800 w.

29934. The New Holyoke Dam. Ill. (R G–March 8.) 500 w.

Hydraulics.

*29149. Water Powers of the Western States Ill. A. G. Allan (E Mag–April.) 4000 w.

29518. The Development of Percolating Underground Waters. Extracts from papers by L. M. Holt and George Manüel (E N–Feb. 21.) 4800 w.

29546. The Cracks in the Reservoirs at Portland, Ore. A. L. Adams (E N–Feb. 21.) 900 w.

29672. The Variation of Pressure in Cornish and Other Pumps. G. E. J. McMurtrie (C M R–Feb.) 2000 w.

Irrigation.

†29485. The Russellkonda Project. Ill. (I E–Jan. 19.) 600 w.

29765. The Pecos Valley.—Some Account of the New Region Being Developed in New Mexico (R A–March 1.) 2000 w.

Miscellany.

29493. The Institution of Civil Engineers, London.—Rebuilding, etc. Ill. (Sc A S–Feb. 23.) 200 w.

29502. Portland Cement. Howard Fleming (S V–Feb. 15.) 700 w.

29517. Materials for Hydraulic Concrete and Best Methods of Mixing. C. H. Platt (E N–Feb. 21.) 1000 w.

*29820. Masonry Dams. Editorial (Eng L–Feb. 22.) 2500 w.

Serials.

27071. Graphic Method of Taking Out Areas, Banks and Cuttings. R. E. (I E–Began Oct. 27—2 parts to date—45 cts. each).

28495. Blackwall Tunnel. Anon. (E–Began Jan. 4—3 parts to date—30 cts. each).

28498. Thames Bridges. Ill. (E–Began Jan. 4—5 parts to date—30 cts. each).

29325. Van Buren Street Rolling Lift Bridge. Ill. (E R–Began Feb. 16—2 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Explosions of Domestic Boilers.

AN editorial in *Engineering* (Feb. 15) indicates that explosions of domestic boilers in England are frequent enough to call for editorial comment in a high-class engineering publication. On February 7 there were 4 such explosions; in 3 days there were 14. On February 10 there were 2, and on the 11th 4. The results, exclusive of notable damage to property, were the death of 6 persons and injury to 24. It is asserted that "last winter, in the course of 2 short frosts, 19 people were killed and 54 injured"; and it is added that "all these accidents, with their attendant deaths, sufferings, and disfigurements, would have been avoided if each boiler had been equipped with a safety-valve costing only a few shillings." Just how these explosions occur is explained in the following quotation:

"Each succeeding night has tightened the grip of frost, and has enabled it to penetrate further into houses and buildings, and here and there to freeze up the circulating pipes in the cold hours of the early morning, when the kitchen fire has died out. Just before breakfast time the cook, cold and sleepy, has lighted the fire, and has urged it to the best of her ability by drawing out the dampers, in order that she might have the hot water required in her department. She has no possible means of knowing if the pipes are free or not, and her only test is, as a rule, one that puts her life to the hazard. If the pipes are free, all is well; but, if the frost has sealed them, the house is wrecked, and, possibly, some of its inmates killed."

It is the kitchen boilers—not those used for heating—that are playing this mischief. Such accidents are rarely heard of in the United States, though frost is much more general and frequent in the northern portions than in England. Safety-valves on kitchen boilers are not commonly used here. Boilers in kitchens frequently collapse under atmospheric pressure when water is drawn off in street-mains and when there has been neglect to vent them by opening faucets; but an explosion of such a boiler is an extremely rare occurrence. Nevertheless, a condition of things implying danger can be imagined. It would not, however, be precisely such as *Engineering* describes. Kitchen boilers are for the most part so connected with the water-backs or fronts of ranges that any total obstruction to their supply pipes will prevent water from running out of the hot-water faucets. Simply opening one of these faucets will show, therefore, whether the supply pipe is free or not. If free, the water in the boiler, when the pressure increases unduly, will back out of the boiler, relieving the pressure. If a hot-water faucet be allowed to run, a supply of cold water is constantly fed to the boiler while the faucet is open, so that undue pressure cannot be generated. Evidently transatlantic plumbers might learn something in the matter of kitchen boilers from American practice.

These accidents have become so numerous in England that their prevention has been discussed by the Board of Trade. Curiously, inquiries by the board into the causes of special accidents of this kind were seriously objected to, on the ground that it would be an unwarrantable interference with private domestic affairs. Mr. Bryce suggested that theorists of the type of Mr. Herbert Spencer would raise objection to the interference of the State with regard to what happened in a private dwelling; that "an Englishman's house was his castle"; and that very wide questions were opened by the proposal. To this *Engineering* very pertinently makes answer that "this objection appears to be based purely on sentiment; it is unsound even in theory, and is contradicted by daily experience of the practical working of the law. Though a householder possesses many sacred rights which are wise safeguards, and should be preserved inviolate, yet there is no law which allows him to do just what he likes, even in his own house. It was not suggested, however, that there should be interference or espionage in every man's dwelling, although, had there been, it would not have exceeded the powers held, and actually exercised daily, by many gas and water companies and by sanitary authorities. The 'castle' theory, as applied to the house of the town-dweller, is pretty well played out, when at least three separate sets of inspectors can override it. Further—and here we come nearer the point at issue—should a domestic boiler explosion occur with fatal results, no sentiment can exclude the coroner and his jury of twelve, who can enter the house and inquire into the origin of the loss of life." Evidently the explosion of kitchen boilers in England is a subject of no insignificant character, since it gives rise to such a debate.

Bedding-Plants.

THIS is the time of year, in latitudes above 40°, for the beginning of spring and summer gardening. The hints relating to the bedding of plants given in an article by Mr. Samuel Parsons in *Scribner's Magazine* for March are therefore timely and useful. "Custom is rapidly doing away with set pieces of cut flowers, artificially and stiffly combined; why," asks Mr. Parsons, "should we not have a similar reform in the use of bedding-plants? Because gardeners of great skill and knowledge succeed in making wonderful combinations of form and color with bedding-plants, which combinations are also artificial, formal, and unnatural, shall we give up altogether one of the most delightful of summer effects?" He intimates that this is the tendency at present. "Crusades against bedding-plants have been carried on by persons of knowledge and taste,—persons whose genuine love and comprehension of the best landscape-gardening ideals cannot be questioned." Without quoting more of the argument, it may be said that many have doubtless felt that good taste was offended by the Persian-rug effects of many of the flower-beds in our public parks, as well as the geometrical patterns in which some gardeners seem to delight. Nature had little regard to geometry when she scattered her flowers over the face of the earth, which was in bloom long before looms or embroidery were thought of. True art in the adornment of parks and grounds will be best attained by such a distribution as produces natural, not strained and artificial, effects.

"Not only must the relations of bedding-plants and shrubs be considered, but the composition of the individual bed of plants must be carefully worked out. You must have a system and be governed by certain general rules, but there must be no mannerism or adherence to any hard-and-fast line of treatment. Every new problem must be studied with regard to its own inherent peculiarity. . . . As a rule, the large plants in a bed should stand in the middle, or at the back, of the group, set against a building or fence. First should come, as in all plant-combinations on the lawn, the lesser effect of grass,—something a few inches high, like alternanthera; then the next greater or small shrub effect, like that of geranium and coleus; then the large shrub effect, like the acalypha and salvia; and finally the tree effect, like the canna and musa. To this general rule you will adhere, but with marked variations that will seem almost at times like transgressions of your most fixed principles. Canna and musa will thrust themselves forward almost, but never quite, to the border of the group, always keeping the acalypha and geranium effect, though ever so narrow, between it and the grass. The acalypha will throw out at times promontories of foliage beyond the foreground itself, and drop one or three plants to grow in isolated places outside of the group on the grass. Geraniums and coleuses will stray across the alternanthera border continually, to overcome all monotony of outline. And yet all through you will find a general adherence to the principle of large plants to the back and small to the front. Only, as you want to treat your bedding in a natural and artistic way, you will continually seek to vary the forms as well as colors, to blend and contrast in such a manner as to surprise and delight in a hundred ways without the slightest trace of monotony or mannered designs. Formalism there is undoubtedly, but it is the formalism of the copes and the forest dell. To explain just how to make these thoroughly artistic arrangements of bedding-plants is, of course, impossible. The painter might just as well attempt to explain how he paints a picture,—how he manages his lights and shades and masses his colors. Practice, experience, and natural aptitude for producing artistic effects, and, above all, the study of the best models, will alone give the desired facility."

The article treats at considerable length of the most available bedding plants, explains the laying-out and designing of beds, and is accompanied by numerous diagrams, and many illustrations of planting that are considered good examples. No circle, horseshoe, harp, anchor, cross, or crescent pattern is to be found among these graceful models. Such artificial, strained effects are justly condemned.

The Heating and Ventilating Engineer.

In a beautiful souvenir number, our esteemed contemporary, *Heating and Ventilation* for February, devotes nearly the whole of its space to the proceedings of the first annual meeting of the American Society of Heating and Ventilating Engineers. The papers read at this meeting indicate that this young society is destined to rank among the foremost engineering associations of the United States. As one looks over the array of heating and ventilating literature presented at the meeting, the paper by Mr. Stewart A. Jellett particularly attracts attention. Leaving the technical side of the profession to be ably dealt with by others, he discusses business aspects, finding that many abuses "and unbusiness-like methods" have crept in. He called the attention of the meeting to the fact that the old maxim, "competition is the life of trade," is capable of misinterpretation. "Competition can overreach itself and become the death of trade, and unregulated competition is to-day the bane of many branches of engineering, and particularly our own. I quote from the Bulletin of the National Association of Builders: 'While we are all competitors, we should still stand firmly together for the correction of errors in practice, and in principles of action.'

"The business of heating and ventilation, as carried on to-day, is capable of three divisions: (1) the engineer who plans and supervises only; (2) the engineer who contracts only; (3) the engineer who does both. The first is dependent wholly for his income from fees received for services, and he is consequently affected by the business methods of the third, who plans as well as contracts. The second looks solely to the profits of his contracts for his remuneration, while the business of the third, if rightly conducted, should pay a profit in each division."

Among the prominent abuses which have injured the profession is "the practice of making plans and specifications for architects and owners free of expense to them. The committee who drew our constitution were impressed with the necessity of correcting this (see article 1, subdivision 8); 'to establish a uniform scale of prices for all professional services.' The scale is nearly uniform now, I regret to say, but, like the winds of heaven, uniformly free to all. I have heard contracting engineers say that this custom has obtained such a firm hold that to refuse to render such services free would kill their contracting business. You can all readily see the effect of such an unbusiness-like practice. It largely kills the business of the consulting engineer, and it takes a large part of the legitimate profits made in contract work to meet the expense of making these plans and specifications. Many of our architects have one or two concerns to whom they send their building plans regularly to have the heating and ventilating and power systems carefully worked out, but with no thought of paying for such services. There is no sound reason why this abuse should not be at once corrected, and there are good reasons why it should be. First, it is unfair to the consulting engineer, who manifestly cannot render such services free. Second, it is unjust to the general customers of the contracting engineer who does it, as the expense of doing it must come from the work done for them, and for which they are paying. Third, it places the architect who accepts such gratuitous services in a position to be justly criticised, as he must either be unfair to the engineer from whom he accepts the service, for which he himself is being paid, or he must be unjust to his client, if the acceptance of such service affects his judgment in deciding the award of contracts for the work. Fourth, it is not business, viewed from any standpoint, and is unjustifiable. Let us, therefore, not adjourn this our first annual meeting, until we have taken the necessary steps for an immediate and radical change in this department."

The present forms of specifications are also criticised. "If any thing or any requirement cannot be accurately defined or stated, it ought to be left out of the specifications entirely. Whatever is required should not be left to be summed up in some indefinite clause like the following: 'The material and workmanship throughout must be entirely satisfactory to the owner and the architect, and the system must be guaranteed in every respect to do the work asked for to their satisfaction.' Who can estimate what it will cost to do anything to another man's satisfaction,—one whom possibly he does not know? This practice came into use in the days when heating was largely a matter of faith in the party employed to do the work, and when there was no general or definite knowledge of the subject. It is the outgrowth of methods that do not exist today, and its use should be dropped. The buyer should be required to decide whether the thing he is asking you to do, when done as specified, will be satisfactory to him or not." The usual guarantee of temperature required by owners from contractors is also objected to, especially for plans and specifications drawn by some one other than the contractor. Inferior material and other abuses are touched upon, and altogether the paper is one that heating engineers will do well to carefully consider. This advice is strengthened by the approval which Mr. Jellett's paper received in the discussion that followed the reading.

Radiating Surface in Hot-Water Heating.

In a paper dealing with the subject of "Hot-Water Heating," in which this method of heating is discussed historically, theoretically, and practically, read by Mr. James Mackay before the Steam Fitters' Protective Association at Chicago (Feb. 18), and printed in *The Metal Worker* (March 21), the author, after stating that hot-water was used by the Romans for heating buildings 1800 years ago, and tracing the history of the method up to the present time, treats the practical side of the subject with reference to the two systems (high-pressure and low-pressure) now in use, the appliances for each, etc. With reference to the apportionment of radiating surface Mr. Mackay says: "The wall surface may be reduced to its equivalent in glass surfaces and the whole figured as so much glass, or each factor may be treated separately. The latter plan I consider best. In apportioning direct radiation to a given room, in which it is intended to maintain a temperature of 70°,—and in the water of the heating apparatus a temperature of 160°,—it has been my experience that 1 sq. ft. of radiation to each 60 cu. ft. of contents, 1 sq. ft. to each 2 sq. ft. of glass, and 1 sq. ft. to each 8 or 10 sq. ft. of outside wall, will do the work properly. Great care must be exercised in judging as to the exposures, construction of the walls, and fitting of doors and windows, together with any local conditions which might affect the result, and due allowance made. If a temperature of 200° be carried in the water, the radiation may be decreased about 20 per cent. To ascertain the amount of direct-indirect radiation required for any given room, the usual method is to ascertain the amount of radiation required, and to this amount to add 25 per cent. I have found under these circumstances that each radiator should have a cold-air duct of an area in the ratio of 40 sq. in. to each 100 sq. ft. of radiation. This duct should be brought through the wall a little above or below the radiator, so that it will make a right-angle turn before entering the base of the radiator. It should be accessible for inspection and cleaning purposes. Air can be delivered through a direct-indirect radiator at a velocity of about 3 ft. per second. Indirect radiation is usually apportioned by adding 50 per cent. to the amount of direct radiation required. This calculation would answer, if wrought-iron surfaces were used, but it is entirely inadequate for heating purposes if cast-iron indirect radiation, taken at its commercial rating. is used. In such a case I should recommend increasing the amount required for direct radiation 100 per cent.; then the amount will not be found any too liberal." Warm air ducts from indirect radiators are often faulty in size. They should be approximately 1½ in. in area for each square foot of the radiating surface of the radiator to which they are connected up to the first floor, 1¼ in. in area per square foot of radiating surface to second floor, and 1 in. in area per square foot of radiation to third floor. The cold air duct may be from 25 to 33 per cent. smaller in area than the sum of the areas in the warm air ducts calculated by the rule. The boxing in of the radiators should be such as to make all their surface effective, that is to say it should be done in such manner as to compel equal distribution of air uniformly over every part of the heating surface.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American and English Journals and Periodicals—Abbreviations are clearly explained in the Introductory.

Heating and Ventilation.

29234. The Heating and Ventilating Engineer.—A Commercial View. Stewart A. Jellett (H & V–Feb. 1.) 1800 w.

29280. Heating and Ventilation in the Public School Buildings of Chicago. Ill. Anon. (M S F–Feb.) 1700 w.

29328. Diagram for Proportioning Heating and Ventilating Ducts. Ill. Carl S. Fogh (E R–Feb. 16.) 2800 w.

29329. An Explosion of a House Heating Boiler, at 308 West 75th St., New York (E R–Feb. 16.) 600 w.

*29387. Hot Air Furnace Heating. By a Practical Furnace Man (D E–Feb.) 1000 w.

29426. Combination Heating for School Houses. W. H. Pennell (H & V–Feb. 15.) 900 w.

29427. Ventilation in New York City. Fred P. Smith (H & V–Feb. 15.) 1400 w.

29430. Some Data Concerning Furnace Systems. S. P. F. (H & V–Feb. 15.) 1400 w.

29730. Hot Water Heating. James Mackay (Met W–March 2.) 4200 w.

29782. Ventilation and Heating of the Residence of Mr. Cornelius Vanderbilt. Ill. (E R–March 2.) 2000 w.

*29853. Warmth and Draughts. Anon. (I C B–Feb. 22.) 1000 w.

*29854. The Ventilation of Sitting-Rooms. H. T. Munday (I C B–Feb. 22.) 1400 w.

Landscape Gardening

*29532. Bedding Plants. Ill. Samuel Parsons, Jr. (Sc M–March.) 3000 w.

Plumbing and Gas Fitting.

*29386. Organization of Master Plumbers' Associations and the Proper Limit of Their Actions. S. E. Dibble (D E–Feb.) 1200 w.

29575. Rules for Plumbing at United States Military Posts (E R–Feb. 23.) 1000 w.

*29608. The Plumber. Anon. (I C B–Feb. 15.) 1200 w.

29883. Cutting Nipples. Ill. William Beall (S P–March 1.) 2500 w.

Miscellany.

*29632. Domestic Boiler Explosions and the Board of Trade. Editorial (E–Feb. 15.) 2000 w.

29669. The Defacement of Scenery. Editorial (G & F–Feb. 27.) 1400 w.

Serials.

26907. Hot Water Heating and Fitting. Ill. J. L. Saunders (H & V–Began Nov. 15—4 parts to date—15 cts. each).

27214. Combination Heating. Ill. J. W. Hughes (Met W–Began Dec. 1—4 parts to date—15 cts. each).

27783. Mechanical Heating and Ventilation. M. C. Huyett (I A–7 parts to date—45 cts. each).

29076. Installing Wood-Cased Bath Tubs. Ill. Grayson (S P–Began Feb. 1—2 parts to date—15 cts. each).

29077. Practical Gas Fitting. Anon. (S P–Began Feb. 1—2 parts to date—15 cts. each).

29281. Steam Heating as Practiced in the United States. David Nesbit (M S F–Began Feb.—1 part to date—15 cts).

29334. Technical Subjects that Plumbers Should Know. F. Dye (Pl D–Began Feb.—1 part to date—30 cts).

29429. The Warming of Residences. Zero (H & V–Began Feb. 15—1 part to date—15 cts).

We supply copies of these articles. See introductory.

ELECTRICITY

Electrical Engineering at Home and Abroad.

AT a recent meeting of the Institute of Electrical Engineers a notable paper was read by H. Ward Leonard, under the title of "Notes on Recent Electrical-Engineering Development in France and England," which is published in the February number of the Society's *Transactions.* As a result of his observations, Mr. Leonard expresses the opinion that from an engineering standpoint America is rapidly losing the lead which it has heretofore maintained in the race of electrical development. He considers the three most important epochs in American electrical progress to have been the establishment of Edison's first three-wire plant at Sunbury in 1883; of Westinghouse's first alternating plant at Buffalo in 1886; and Sprague's first electric railroad at Richmond in 1888. What, asks Mr. Leonard, has been done in this country in the way of remarkable electrical-engineering development since these dates? He answers by affirming that in this country the practical development of electrical-engineering improvements—meaning presumably those of an original or radical nature—is well-nigh impossible by reason of the opposition of the gigantic corporations which seek to control the whole field, and that corporations having so large a proportion of their capital represented by patents do not desire the practical trial of a promising improvement which they do not control, and which may depreciate the value of methods which they do control or claim to control. It is for this reason, Mr. Leonard thinks, that we are now losing ground as compared with England and France. On his hurried trip abroad, he remarked many instances of inventions of American engineers which had proved highly successful, and which, although patented, described, and advertised in America, had been first taken up by English or French engineers, notwithstanding their well-known prejudices against American inventions. In England there is a multitude of medium-sized manufacturing concerns, and the competition seems to be rather upon ideas than upon the price of dynamos per kilowatt. Mr. Leonard was somewhat surprised to find generators and motors much cheaper in the United States than in England or France, nothwithstanding the advantages of these countries over ours in respect to cheaper materials and labor. Rotary transformers are used in several stations for a continuous-current, high-potential, multiple-arc distribution, and in some places the standard 220-volt three-wire system is supplemented for distant lighting by an alternating system using 2000 volts in the primary and a 220-volt 3-wire secondary, which, during the period of light load, is switched directly on to the regular 3-wire system. The steam-turbine is gaining favor abroad as a motor for electric-lighting plants. A station of twenty-five thousand lights at Newcastle-on-Tyne has been operating solely by Parsons's turbines for 5 years and paying regular dividends. Similar turbines have also been recently placed in one of the London stations of the Metropolitan Company, and are found to be no less economical than the compound condensing reciprocating engines which they superseded. Mr. Leonard examined a storage-battery plant in Paris, capable of supplying 8000 10-c. p. lamps for 3 hours. It cost $30,000 and weighed 400,000 lbs. It was well-designed and seemed to be in good order. He is not surprised at the assertions as to the inefficiency of transatlantic stations which do not use batteries; inasmuch as, owing to the limited use of motors abroad, most of the central stations are run practically without load the greater part of the 24 hours. He puts this matter very forcibly when he says: "The portion of the total cost of each kilowatt-hour produced, which depends upon the maximum load, is about two-thirds of the total cost, and the part dependent upon the actual output is only about one-third. The average load-factor in an English central station is less than 15 per cent., and only rises to 33 per cent. in London in December, while in most American cities it is 50 per cent. or more. Among other matters, Mr. Leonard carefully investigated the Heilmann electric locomotive, of the possibilities of which he speaks with great enthusiasm. Space forbids a summary of his observations upon this peculiar machine, but it is probable that the early practical trial of the scheme will show whether Mr. Leonard's somewhat sanguine expectations are likely to be fulfilled.

Electrical Education.

PROFESSOR EDGAR KIDWELL of the Michigan Mining School has a very excellent paper on the above subject in the *Electrical Engineer* (Feb. 13), written by way of comment and criticism upon a previously published article on the same subject by Professor Stine of the Armour Institute. The author takes vigorous exception to the far too common practice of introducing irrelevant matter into papers read before engineering societies. "Most engineers," he says, "have far too little time for private study, and it is all important that he who writes for them bear that fact in mind, drop all useless attempts at flowery language, stick close to the subject, present clearly and accurately the matter under discussion, go straight to the point, and not waste the reader's time, or distract his attention, by lugging in illustrations, comparisons, etc., which show nothing, but only befog the understanding." Referring to the methods of instruction in many of our technical schools, the author makes the eminently judicious observation that "today one of the greatest stumbling-blocks to progress in most electrical-engineering courses is that a large amount of the professor's time has to be wasted in giving the kind of elementary instruction which had better be done in the department of physics." The ground which had been taken by Professor Stine—*viz.*, that the course of instruction for an electrical-engineering student should be confined principally to electrical matters (mechanical engineering, shop practice, etc., being excluded, or else given in a very elementary manner, "since proficiency in these latter branches is not now essential to the electrical engineer, or at least is less important than it was formerly")—is severely, but justly, criticised by Professor Kidwell. He says: "He who desires to succeed as an electrical engineer must of necessity be an adept in many branches of mechanical engineering. He must know the general principles of *all* engineering, and no amount of electrical knowledge alone will make him an engineer any more than a knowledge how to turn up governor-balls will make one a machinist." Again he says: "No course in electrical engineering, irrespective of the thoroughness with which the electrical work alone is done, can properly prepare men for active practical engineering work according to the requirements of today, unless such a course includes a thorough training in the fundamental principles of mechanical engineering. . . . There are today stations running and giving good satisfaction, which are directed by mechanical engineers of rather limited electrical attainments. I can recall some others run entirely by the electrical end of the concern. No customer dares dispense with his oil lamp, for the regular programme seems to include a shut-down about once a week to tinker with some hot box, etc." Such a discussion is calculated to do much good, but there can be no doubt that the views of Professor Kidwell will be strongly endorsed by all experienced electrical engineers.

Electrical Illumination of Churches.

THE Roman Catholic church has always had the reputation of being an extremely conservative organization, yet it is interesting to remark that in the decorative utilization of that extremely modern illuminant, the electric incandescent lamp, in some of its principal places of worship, it easily takes precedence of its sister churches. In *Electricity* (Feb. 20) R. M. Bernard tells in a very attractive way how science and art have joined hands in the embellishment of some of the principal temples of worship of this communion in the city of New York. The pioneer in this particular field of work was Mr. D. Colombani, formerly of the Edison Illuminating Company, and his first undertaking of the kind was in the Church of the Holy Innocents in West Thirty-seventh street, which was completed near the end of 1889. It was not, however, until Mr. Colombani had obtained *carte blanche* to carry out his own ideas and conceptions in the decorative illumination of St. Francis Xavier's on West Sixteenth street that he was able to fully demonstrate the wonderful possibilities of the new illuminant in this direction. Since that time he has successively carried out similar installations in several of the principal churches in New York and Brooklyn, each of which, having its individual architectural peculiarities, afforded a wide scope to the artistic genius of the designer. In undertaking the illumination of an altar, a statue, or any special architectural feature, the artist always set himself the task of bringing out by the aid of electric lamps the particular points which, for ecclesiastical or other reasons, it was desirable to emphasize. Mr. Bernard's article contains descriptions of a number of these features, and is accompanied by excellent and artistic illustrations. Some of these special designs are conceptions of high artistic merit, and, moreover, show great skill in the adaptation to them of the desired character of illumination. It is a paper which church architects may study with pleasure and profit.

Arc-Lighting Up to Date.

ELECTRICAL INDUSTRIES (Feb.) contains a well-written and well-illustrated article descriptive of the new arc-lighting plant of the Mutual Electric Light and Power Company of Chicago, which is notable as marking a distinct departure, in many important respects, from the hitherto generally accepted practice in the United States, in the engineering and equipment of stations of that type. The arc dynamos commercially operated in this country fifteen years ago were run at a speed of more than one thousand revolutions per minute, and, as the only engines then made in other respects suitable for the purpose were practically limited to a speed of some two hundred and fifty revolutions, it became necessary to employ belting and countershafting,—a practice which has been largely followed down to the present day. During all the intervening years the dynamo-designers have endeavored to reduce the speed of their machines, while, on the other hand, the engine builders have sought to increase their speed, until at length the engine and dynamo, so to say, have been brought together, and the new station, now described, is the successful result of this advantageous mutual adjustment. The Brush Electric Company has produced an arc-dynamo having a capacity of 125 2000-c. p. lights, the speed of which is only five hundred revolutions per minute, while the M. C. Bullock Manufacturing Company has brought out an engine of the Willans type of equal speed, and in all other respects admirably adapted to the required service. It is worthy of note that in this process of evolution the engine and dynamo have, as it were, met exactly at the half-way point; the speed of the engine has been exactly doubled, while that of the dynamo has been cut in half. The engine and dynamo are now mounted upon one bed-plate, and occupy a floor space of only about 45 sq. ft. Three of these combinations constitute the present plant of the Mutual Company. The district lighted is a residence section of Chicago, 46 sq. miles in area and containing a population of nearly 300,000. The article gives full details of the construction of the engines, boilers, switch-boards, and minor appliances, which, although severally of more than usual excellence, appear to present no features calling for special mention here. One of the most striking illustrations accompanying the article is that showing a ground plan of the very common arrangement of a Corliss engine belted to two dynamos, and on the same scale, for convenient comparison, the Willans engine driving directly a single dynamo of equivalent capacity. The respective areas of floor-space occupied are exactly as eight to one. In fact, under the new organization, only 1 sq. ft. of floor space in the central station is required for each 2000-c. p. light operated, while the economy in other directions is very great. There can be little doubt that in future this will become a standard and representative type of the larger class of arc-lighting stations, and, as such, will repay careful study by electrical engineers and designers.

The Electrical Industries of Cleveland.

THIRTY years ago, when telegraphy was practically the only recognized electrical industry, Cleveland was the headquarters of the Western Union Telegraph Company,—then, as now, the largest electrical corporation of the world. Naturally there grew up in that city shops for the manufacture of various telegraphic and electrical instruments and appliances, and in this way it happened that, when Mr. Charles F. Brush had designed the dynamo machine and system of arc-lighting which have made his name a household word throughout the civilized, to say nothing of many portions of the uncivilized, world, he entered into business relations with a concern in the city of his residence, already engaged in this kindred line of work, for the manufacture and introduction of his inventions. From this beginning grew up the Brush Electric Company, at one time the principal establishment in the world engaged in the manufacture of electric-lighting appliances. Thus Cleveland has always been peculiarly a city of electric manufactures. In view of the recent meeting in that city of the National Electric Light Convention of central station managers, the *Electrical Engineer* (Feb. 20) devotes a large amount of space to a series of illustrated articles, some of them of a very elaborate and interesting character, relating to the electrical industries of Cleveland, as well as to the personal histories of some of the men who have been prominently identified with the establishment and management of these enterprises. The Brush interests, as a matter of course, are accorded the place of honor in the list. Over 150,000 arc-lamps are nightly burning in the streets and public places of our cities and towns, the product largely of this immense establishment. Twenty-six million arc-carbons were made by this company in 1893. The newly-completed factory of the National Carbon Company is also described. It covers 26 acres of floor-space, and comprises fourteen buildings,—some of them of enormous dimensions. Its total capacity is two hundred million carbons per annum. Other prominent establishments described and illustrated are those of the Buckeye Lamp Company, the Walker Manufacturing Company, the Universal Electric Company, and the Elwell-Parker Electric Company of America. Interesting articles are also given containing descriptions of the technical schools for which Cleveland has acquired such a deservedly high reputation, among which are the Case School of Applied Science and Professor E. P. Roberts's Correspondence School of Technology. Practical electrical engineers will also find much of interest in the illustrated descriptions of the new plants of the Cleveland Electric Illuminating Company, and of several of the electric-railway plants of that city. It must be admitted that in matters electrical Cleveland makes a fine showing.

Death of An Electrical Pioneer.

IN the *Electrical Engineer* (March 6) Franklin L. Pope has a brief biographical sketch and portrait of Royal Earl House, an inventor of consummate ability, prominently connected with the early history of electric telegraphy in this country, who died in Bridgeport, Conn., on February 23, at the age of 81. House achieved fame and fortune as the originator and constructor of the earliest successful type-printing telegraph, first invented in 1844 and finally perfected in 1848,—a perfect marvel of mechanical and electrical skill, which was capable of printing communications in Roman characters, at a rate of over fifty words per minute, by the action of compressed air controlled by electricity, and of keeping up this rate of work for an indefinite period. Both as an electrician and a mechanician House may fairly be said to have been a quarter of a century in advance of his contemporaries. For the past forty years he has lived a retired life, occupying himself largely in the development of an automatic system of telegraphy, which, however, failed to meet with commercial acceptance. He was a man of fine physique and attractive personality, and one whose work in the history of electrical development was of sufficient importance to entitle him to rank among the foremost inventors of the nineteenth century.

Electric Annealing of Armor Plate.

ARMOR plates which have been subjected to the Harvey process are covered with a skin of hard steel of half an inch or more in thickness, and it has been a serious question how such plates could be locally annealed so that they could be drilled and tapped at points necessary for the insertion of bolts or other fastenings, especially as the application of the most intense heat that could be produced by the oxy-hydrogen blow-pipe has proved to be wholly ineffective for the purpose. In the *Electrical Engineer* (March 6) Professor Elihu Thomson tells how this difficult problem has been solved by Mr. Herman Lemp, an expert in electric-welding processes. Mr. Lemp's method consists in passing a current between two electrodes placed a certain distance apart and in contact with the surface of the plate, and thus heating a portion of the plate to an annealing temperature, after which, by a very careful diminution of the current, the temperature is slowly lowered so that the too rapid cooling by conduction of heat to the mass of the plate back of the heated portion shall be prevented from acting as a chill on the heated metal. The use of alternating currents derived from a transformer, as usual in welding processes, favors the concentration of the heating effect and the local flow of current. The reactive inductive effect is least where the current flows near the surface of the plate from one electrode to the other, so that any current seeking to diverge from the direct path and enter more deeply into the substance of the plate has to traverse not only a longer path, but one in which self-induction acts to limit the flow. The value of this process was demonstrated in the case of the war-ship "Massachusetts" under construction at the Cramp yard, it having been found that certain plates for the barbette were hard where it was absolutely necessary that they should be drilled and tapped. The building of the upper deck of the vessel was delayed, while experiments were vainly made with the blow-pipe to soften the plate so as to permit of drilling. The application of the electric process solved the problem at once, and Mr. Lemp's apparatus will doubtless soon become one of the essential features of the equipment of a modern ship-yard.

Electricity on Ordinary Railways.

THE *Electrical Engineer* (Feb. 13) prints a number of communications from such authorities as Professor Elihu Thomson, Messrs. Houston & Kennelly, and H. Ward Leonard, expressing their respective views as to the problem of applying electricity to the operation of standard railways, and giving their reasons therefor. Professor Thomson favors overhead conductors, and advocates the self propelling motor car for local and suburban traffic, and independent locomotives for long and heavy trains. He regards a pressure of 1000 volts as feasible for ordinary work, but is of the opinion that for long distances conversion systems will have to be used. The views of Messrs. Houston & Kennelly are substantially the same as those of Professor Thomson, although they suggest that it would be preferable to work tentatively in the direction of the general line of development of the existing street-railway systems, rather than to attempt any radical innovation. Mr. Leonard is a believer in independent locomotives, and in transmission by the alternating current at high pressure, to be transformed on the locomotive to a continuous current. The discussion is an interesting one, and it is worthy of remark that there seems to be no substantial difference of opinion among the best expert authorities as to the general features of the successful electric railway of the future. In the following number of the same journal (Feb. 20) the symposium is continued. Professor W. A. Anthony points out that one of the most important desiderata in electric-railway work is some efficient and trustworthy means of maintaining the motor at high efficiency under varying speeds. Mr. Leonard's plan, while providing for an economical variation of speed, labors under the disadvantage that it requires a 500-h. p. locomotive to be equipped with 1500 h. p. of electrical machinery. Professor Anthony thinks a potential of 1500 volts may be successfully used. With Professor S. H. Short, who follows him, he favors overhead conductors, and a frequent express service of light trains or motor cars. B. J. Arnold of Chicago, a prominent engineer, maintains practically the same views in respect to the arrangement of conductors, and the pressure to be used, and thinks that standard practice tends to the adoption of a locomotive having two or more axles, with a motor on each axle. This is substantially the design of the new locomotive now building for the Baltimore and Ohio R. R.

High Voltage Lamps for Central Stations.

In an article in the London *Electrical Review* (January 11) Mr. G. L. Addenbrooke presents a strong plea for the adoption of high-voltage lamps for central station service. "How great a gain there is in distributing current at a higher voltage, and how much it simplifies the distribution problem, is not at first sight fully apparent, but they may really be said to progress as the cube of the voltage, up to, say, about 200 volts. "It is well within the mark"—says Mr. Addenbrooke—"to say that at 200 volts nine or ten times the area could be better served on the three-wire system from a single station than is now the case at 100 volts." Nothing, he thinks, really stands in the way of such a consummation but the existence in such numbers of the 8-candle lamp. A high-voltage lamp once secured, the whole central-station distribution problem becomes simplified, and an important factor in cheapening further the cost of supplying current is secured. A higher voltage would also get rid, without extra outlay, of the annoying loss of pressure on customers' premises, which frequently amounts to 2 per cent., and which makes a difference of 10 per cent. in the amount of light given by lamps near the mains and at distant points. A number of other incidental advantages to be gained by the change are pointed out, which added to those named make the argument of Mr. Addenbrooke stronger than might appear from this somewhat brief review of his well written paper.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Lighting.

*29153. Reducing the Cost of Electric Light. Nelson W. Perry (E Mag–April.) 3000 w.

*29178. The Amsterdam Electric Lighting Station. Ill. (E–Feb. 1.) 1400 w.

*29236. Three Central Electric Light Works. Halifax-Nottingham-Dewsbury. Ill. (E R L–Feb. 1.) 5200 w.

29290. An Electric Lighthouse. Ill. (E W–Feb. 16.) 1700 w.

29363. The Gas Engine and Electric Lighting. From an Electrician's Standpoint (B J C–Feb. 16.) 1200 w.

29399. The Model Arc Lighting Plant Recently Installed by the Mutual Electric Light and Power Company of Chicago. Ill. (E I–Feb.) 3200 w.

*29408. Wolverhampton Corporation Electricity Works. Ill. (E R L–Feb. 8.) 4000 w.

*29410. The Cannon Street Explosion. (Report.) (E R L–Feb. 8.) 5500 w.

29441. The Influence of the Carbons on the Candle Power of the Arc Light. Wilbur M. Stine (E W–Feb. 23.) 4000 w.

29443. Buffalo Electric Lighting Plants. Ill. Frank C. Perkins (E W–Feb. 23.) 1000 w.

29446. What Shall We Pay our Firemen? J. B. Calhoon (E W–Feb. 23.) 2000 w.

29451. The Great Brush Windmill Lighting Plant. Ill. (E N Y–Feb. 20.) 800 w.

29452. Church Illumination. Ill. R. M. Bernard (E N Y–Feb. 20.) 4200 w.

29454. The Lighting of Cleveland (E N Y–Feb. 20.) 1400 w.

*29565. Dioptric Glass Shades and Holophane Globes. Ill. André Blondel (E R L–Feb 15.) 1600 w.

*29566. Some Points on the Working of Central Stations. J. Hardie McLean (E R L–Feb. 15.) 1500 w.

*29617. The Chemnitz Three-Phase Electric Lighting Station. Ill. (El–Feb. 15.) 2500 w.

*29637. The Electricity Works at Blackburn. Ill. (E E L–Feb. 1.) 4000 w.

*29638. Water-Power Installations for Electric Lighting. E. R. Dolby (E E L–Feb. 15.) 1200 w.

29649. "The Storage of Energy Essential to Economy of Working in Central Stations." Nelson W. Perry, with Discussion (E R N Y–Feb. 27.) 13500 w.

29650. "Correct Method of Protecting Electric Circuits." W. E. Harrington (E R N Y–Feb. 27.) 1600 w.

29671. The Monocyclic System. Ill. Louis Bell, with Editorial (E N Y–Feb. 27.) 6000 w.

29707. The Early History of Arc Lighting. Charles F. Brush (E W–March 2.) 1500 w.

29708. Large Arc Dynamos. Abstract of paper by C. N. Black, with Discussion (E W–March 2.) 2800 w.

29709. Arc Carbons and the Rating of Arc Lamps. L. B. Marks (E W–March 2.) 2800 w.

29723. Electric Lighting at Belfast. Alexander B. W. Kennedy (P A–March 1.) 800 w.

*29806. Electric Lighting Engines at the Neubad and Leopoldstadt Central Stations, Vienna. Ill. (E-Feb. 22.) 1600 w.

*29827. Double Refraction in Electric Rays. K. Mack (El–Feb. 22.) 3000 w.

29850. Decision in Bate Case—Incandescent Lamps Free (E E N Y–March 6.) 3300 w.

29926. A New Method of Measuring Illumination. Edwin J. Houston and A. E. Kennelly, with Discussion (E W–March 9.) 5000 w.

Power.

*29225. The Depoele Boring Machine in Hungary (C G–Feb. 1.) 1000 w.

29272. The Utilization of Water Power in California—The Folsom Sacramento Transmission. Ill. George Heli Guy (E E N Y–Feb. 13.) 1800 w.

29323. The Electric Motor in the Machine Shop. George Richmond. Read before A. S. M. E. (E R–Feb. 16.) 2000 w.

29444. Coal Consumption in Central Stations. E. A. Merrill (E W–Feb. 23.) 2000 w.

29450. Central Station Economy. Editorial (E N Y–Feb. 20.) 1400 w.

†29487. Generating Electricity by Windmills. I. N. Lewis (I Eng–Jan. 19.) 4300 w.

29536. About Dynamos—Their Practical Care and Management. H. Buck (B J C–Feb. 23.) 1000 w.

*29639. Reversible Regenerative Armatures and Short Air-Space Dynamos. W. B. Sayres, with Discussion (E E L–Feb. 15.) 4600 w.

29700. Electric Motors for Driving Machine Tools. Condensed Letter From M. Melotte (E N–Feb. 28.) 500 w.

29703. The Stanley Electric Manufacturing Company and its Two-Phase Work. Ill. (E E N Y–Feb. 27.) 3500 w.

*29769. Distribution of Electrical Energy in Mills. Ill. (M W–Feb. 22.) 2500 w.

29873. Municipal Ownership of Niagara Power Distribution for Buffalo. Frank C. Perkins (E N Y–March 6.) 2000 w.

29888. Storage Battery Plant for Electric Light and Railway Work at Merrill, Wis. Ill. (E R N Y–March 6.) 1300 w.

†29894. Action of a Single-Phase Synchronous Motor. Frederick Bedell and Harris J. Ryan (J F I–March.) 6000 w.

29946. Storage Battery Plant for Light and Railway. Herbert Condict (E M J–March 9.) 1800 w.

Telephony and Telegraphy.

29270. The Telephone Station in the Main Post-Office at Leipzig. Ill. (Sc A S–Feb. 16.) 500 w.

29278. The Latest Long Distance Telephone Transmitter. Ill. (Sc A–Feb. 16.) 1200 w.

29279. The Blake Transmitter. Ill. (Sc A–Feb. 16.) 2000 w.

29301. The New Telephone System of Paris. Ill. E. Hospitalier (E A–Feb. 16.) 2500 w.

29310. Modern Telegraphy—Rapid Printing Telegraphy. Ill. (I Age–Feb.) 2000 w.

29360. The Pneumatic Telegraphs of Paris. Samuel E. Morss (A A–Feb. 16.) 3800 w.

29390. The Carbonnelle Microphone for Long Distance Telephony. Ill. From L'Industrie Electrique (E R N Y–Feb. 20.) 1200 w.

29392. Telephone Cables With Dry Air Circulation. A. Barbaret (E R N Y–Feb. 20.) 1500 w.

29453. Pictorial Telegraphy. Ill. Nelson W. Perry (E N Y–Feb. 20.) 1300 w.

29520. Specifications for Electrical Cables for Baltimore Subways. Ill. (E N–Feb. 21.) 3000 w.

29875. Royal E. House and the Early Telegraph. Ill. Franklin Leonard Pope (E E N Y–March 6.) 1000 w.

Miscellany.

*29171. Electric Discharge Through Gases. Ill. J. J. Thomson (E E L–Feb. 1.) 3500 w.

*29215. Some Continental Electric Supply Stations. G. F. Metzger (El–Feb. 1.) 2800 w.

*29216. Fleuriais' Electric Log. Ill. (El–Feb. 1.) 1500 w.

*29218. "Labor Saving" Apparatus as an Instrument of Education. J. A. Fleming (El–Feb. 1.) 1400 w.

*29235. Toepler High Frequency Experiments (E R L–Feb. 1.) 1400 w.

29267. On a Proposed Modification of the Generally Accepted Temperature Co-efficient of Resistance for Copper Wires. A. E. Kennelly and Reginald A. Fessenden (E R N Y–Feb. 13.) 500 w.

29269. Results of the Elihu Thomson Competition. B. Abdank-Abakanowicz (E N Y–Feb. 13.) 2000 w.

29271. Protection From Lightning. Alexander McAdie (Sc A S–Feb. 16.) 7000 w.

29273. Electrical Education. Edgar Kidwell (E E N Y–Feb. 13.) 4200 w.

29288. Does Execution by Electricity, as Practiced in New York State, Produce Instantaneous, Painless and Absolute Death? Observations Made at the Execution of David Hampton, at Sing Sing, Jan 28, 1895. A. E. Kennelly and Augustin H. Goelet (E W–Feb. 16.) 1300 w.

29291. The Effect of Armature Current on Magnetic Leakage in Dynamos and Motors. Harry D. Frisbee and Alexander Stratton (E W–Feb. 16.) 2500 w.

29318. The Schafer-Heinemann Accumulator. A. M. Gibson (E M J–Feb. 16.) 2500 w.

*29335. Juvenile Lectures on Electricity. (Abstract.) J. A. Fleming (Pl D–Feb.) 1700 w.

29389. On Experiments with Tesla Currents. F. Himstedt in "Weidmann's Annalen." (E R N Y–Feb. 20.) 800 w.

29391. Primary Battery Testing.—Methods and Apparatus of the German Telegraph Department for Finding Commercial Efficiency. V. M. Berthold (E R N Y–Feb 20.) 1000 w.

29401. Electricity for Mechanics. Ill. George Cutter (E I–Feb.) 1300 w.

29438. A New Method for Deducing the Expression for Electromagnetic Force. Cary T. Hutchinson and E. R. Carichoff (E W–Feb. 23.) 500 w.

29442. The Electrical Transformer. Ill. Caryl D. Haskins (E W–Feb. 23.) 3400 w.

29445. Iron-Armored Conduit Construction. Ill. George T. Hanchett (E W–Feb. 23.) 1000 w.

†29596. Notes on Recent Electrical Engineering Developments in France and England. H. Ward Leonard (T A I E E–Feb.) 6800 w.

*29619. Transformer Chambers. Ill. (El–Feb. 15.) 600 w.

*29623. The Influence of Temperature on the Magnetization of Iron and Other Magnetic Substances. Henry Wilde (C G–Feb. 15.) 1300 w.

29702. The Leonard Electrically Heated Apparatus. Ill. H. Ward Leonard (E E N Y–Feb. 27.) 1300 w.

*29797. Experiment for the Demonstration of Thermo-Electric Currents. Ill. Ch. Ed. Guillaume (E R L–Feb. 22.) 500 w.

29874. The Electric Annealing of Armor Plate. Elihu Thomson (E E N Y–March 6.) 1100 w.

†29893. The Application of Electricity to the Bleaching of Textile Fabrics. Ill. Louis J. Matos (J F I–March.) 5400 w.

29925. A Straight Line Accumulator Characteristic. Carl Hering (E W–March 9.) 600 w.

29945. Action of the Electric Current on Fused Sulphurets. (Abstract.) Jules Garnier (E M J–March 9.) 600 w.

Serials.

9531. Suggestions for Metering Devices. Ill. S. D. Mott (E W–Began Jan. 14, 1893—7 parts to date—15 cts. each).

22059. Practical Notes on Dynamo Calculation. Alfred E. Wiener (E W–Began May 19—31 parts to date—15 cts. each).

23866. Electro-dynamic Machinery. Ill. Edwin J. Houson and A. E. Kennelly (E W–Began July 21—26 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (E A–Began Aug. 25—22 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Ill. Howard Pentland and Alfred H. Gibbings (E L–Began Oct. 5—21 parts to date—30 cts. each).

26592. Electrical Power Transmission. Louis Bell (E W–Began Nov. 10—15 parts to date—15 cts. each).

27371. The Electric Light. Henry Stooke (I C B–Began Nov. 23—14 parts to date—30 cts. each).

27704. Some Hints on the Building of Electric Plants. Charles G. Armstrong (E I–Began Dec.—3 parts to date—15 cts. each).

27855. Method of Determining the Efficiency of Dynamos and Motors. J. Reginald Ashworth (E P–Began Dec.—Ended Feb.—3 parts—30 cts. each).

28759. The Electric Arc. Hertha Ayrton (El–Began Jan. 18—4 parts to date—30 cts. each).

29132. The Mechanics of Electro-Magnetism. Ill. Wilbur M. Stine (E A–Began Feb. 9—Ended Feb. 16—2 parts—15 cts. each).

29156. Technical Telegraphy Papers. James Bell and S. Wilson (E L–Began Feb. 1—4 parts to date—30 cts. each).

29158. The Construction and Use of Electrical Measuring Instruments. C. H. Yeaman (E L–Began Feb. 1—4 parts to date—30 cts. each).

29159. Notes on Search Lights. Ill. J. Watts (E L–Began Feb. 1—3 parts to date—30 cts. each).

29287. On Magnetic Potential. Frederick Bedell (E W–Began Feb. 16—1 part to date—15 cts).

29289. On Potential. Wilbur M. Stine (E W–Began Feb. 16—2 parts to date—15 cts. each).

29615. On the Delineation of Alternating Current Curves When the Alternator Is Not Accessible. Ill. J. A. Fleming (El–Began Feb. 15—2 parts to date—30 cts. each).

29616. Core Losses in Alternate-Current Transformers. Ernest Wilson (El–Began Feb. 15—Ended Feb. 22—2 parts—30 cts. each).

29640. The Application of the Electric System of Welding to Machinery and Boiler Repairs. Ill. Henry Foster (E E L–Began Feb. 15—Ended Feb. 22—2 parts—30 cts. each).

29798. On Slow Changes in the Magnetic Permeability of Iron. William M. Mordey (E R L–Began Feb. 22—1 part to date—30 cts).

29829. Propagation of Magnetization of Iron as Affected by the Electric Currents in the Iron. Ill. J. Hopkinson and E. Wilson (El–Began Feb 22—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY

Freeland.

A GROUP of papers in the *Fortnightly Review* is entitled "Side-Lights on Socialism." Among these a paper entitled "Experiments in Colonization," by Edward Salmon, gives an account of a scheme based on principles enunciated by Dr. Theodor Hertzka, an Austrian economic prophet not without honor in his own country, whose teachings are gaining attention throughout Europe. Dr. Hertzka is the author of a book entitled "Freeland: A Social Anticipation," which has been widely circulated in the original, and has been recently translated into English by Mr. Arthur Ransom. The burden of the book is the outlining of a social organization, in which "economic justice" shall be attained on lines of individualism rather than communism.

"Freeland is to be the natural product of evolution. Dr. Hertzka does not denounce either past or present, but has come to the conclusion that civilization is moving towards an economic state, as different from the present as the present is from the remote past. Man in early days took to fighting his neighbor, and, if he vanquished him, ate him; cannibalism gave place to serfdom, when the victor came to understand that his captured enemies could be utilized to his profit. By the efforts of his people the master obtained wealth and leisure—two necessaries of discovery and scientific progress. Hence, with those who condemn the system of landlordism and capitalism, as it has obtained up to the present, Dr. Hertzka has no sympathy. Without that system society would not have advanced—at any rate as rapidly and effectually as it has done—beyond the barbaric stage. A philosopher who takes that view may be trusted to lend no ear to those who would unconditionally confiscate property. He does not regard all wealth, and all exploitation of other people's labor, as robbery. 'Exploitation,' he says, 'is robbery only in an economic, not in a judicial sense; it was not merely considered to be permissible, it was permissible. . . The appropriation of other men's earnings, which in an economic sense we are compelled, and rightly so, to call robbery, was, let us not forget, the necessary condition of any really productive, highly organized labor, so long as the workers were not able to freely organize and discipline themselves. Economic robbery, the relation of master held by the few towards the many, constituted an effective economic service that had the strongest right to claim the profit of other men's labor, which was in fact rendered profitable by it. Subsequently to confiscate the thus acquired compensation for the services rendered, because such services had become superfluous, or indeed detrimental, would in truth be robbery, not merely in an economic sense, but in a legal sense,—an offence against the principles of economic justice.' That is a standpoint which will please neither uncompromising Tory nor determined Socialist, but it is one which may conceivably acquire strength in proportion as it is fully understood. Wholly consistent with the foregoing are the Freelander's views on wealth. He does not regard wealth as a wicked and wrongful possession because it is something which others have not. He regards with stern disapproval only that wealth which is due to exploitation. Herein we find a note struck which has no likeness in any other advanced economic system. All attempts at the realization of the Socialist propaganda have failed, or are considered by Dr. Hertzka to have failed, because they have aimed at equality, not of wealth, but of poverty, at levelling down instead of levelling up,—a process which carries with it stagnation and decay."

At first all this reads like many of those economic generalizations which have been put forth in profusion during the last decade. But, closely studied, one sees that it is an extension into ethics and economics of the old princple that *ex post facto* legislation is injustice. The leading points of Dr. Hertzka's "Freeland" scheme are as follows: "At the beginning of March last the Freeland Pioneers set sail from Europe to Africa to discover a site for a colony which was to be brought into existence in response to Dr. Hertzka's teaching. . . . Difficulties, physical and moral, prevented the pioneers from reaching the spot in Africa whither they were bound. The pioneer enterprise proved a failure, and Freeland has yet to be located." This brief but comprehensive history does not, however, justify the conclusion that the experiment will never be tried. Mr. Salmon thinks the scheme has something to recommend it and hopes it may yet have a trial; and it appears that there is a greater or less following throughout Europe of like mind.

The first prominent feature of the scheme—individualism as opposed to communism—has been mentioned. "There is to be no monotonous uniformity of reward for widely-varied services, and no indifference to superior claims." Men are to be paid according to value of services rendered, and may amass personal property as they can find means and opportunity to do so. But there is to be no private ownership of land (here the scheme runs parallel with the Single Tax doctrine), and no capitalism, because interest on capital is to be abolished, interest being, in Dr. Hertzka's opinion, the parent of capitalism. Under these favoring conditions wealth is expected to be generally diffused, and it is anticipated that work will be provided for every able-bodied man, while there will be no lack of asylum for the halt, the aged, and the very young. Unmarried women will have adequate provision made for them by the State. Freeland will be a paradise for spinsters, but it is not expected that many women will remain unmarried on that account. Women's work is to be "the education of children and the care of the sick and the infirm." These are the salient points of the scheme. Unlike Mr. Salmon, we do not hope it will reach the experimental stage. The moral difficulties met with in the pioneer effort to select a site will become far more formidable if a site shall ever be found and occupied by a colony made up of such human elements as would be available for colonization; and the inevitable failure, with its attendant sorrow and suffering, would only be a repetition of a too oft-told tale.

Compulsory Arbitration.

NOTWITHSTANDING the fact that compulsory arbitration has been shown to be in its very essence an impracticable scheme,—a method of settling disputes which must in the nature of things leave dissatisfied one or both sides to a controversy between employers and employed,—there are yet many who cannot see the inherent weakness of the system, and who advocate its adoption. A discussion of compulsory arbitration as related to the settlement of the frequently-recurring labor troubles in the mining districts of the United States, more particularly in the coal-mining regions of Pennsylvania, communicated by an American correspondent, is printed anonymously in *The Colliery Guardian*. It is stated that the success of the system of voluntary arbitration in the English mining districts was used as an argument in urging the Pennsylvania coal and iron industries to adopt the method. But neither in Pennsylvania or any other State have proposals on these lines been taken up with any great amount of heartiness; and masters and workmen now find themselves, as the result of their inability to settle their disputes without serious loss and sometimes danger to the general community, face to face with a suggestion that arbitration should be made compulsory by law. The matter was prominently referred to at the recent annual convention of the American Federation of Labor, held at Denver, Colorado, and again at the Industrial Arbitration Congress held lately in Chicago. "Mr. Carroll D. Wright, government commissioner, is the main author of the compulsory arbitration scheme, which, before long, seems likely to be brought before the congress. The exact details of the scheme are not before us, but among the general public, who would be glad to be relieved, at almost any cost, of the tremendous hindrance to business caused by strikes in the United States, particularly when the strikers get hold of the railroads, the suggested new legislation is received with favor. It is, however, a very striking circumstance that among the parties most concerned—*viz.*, the employers and workmen themselves—the idea is received with scant courtesy. In the Pennsylvania mining districts this opposition is very strong, neither the miners nor coal owners seeming willing to accept State interference. At the Industrial Congress in Chicago the new departure was stoutly opposed by the president of the Amalgamated Association of Iron and Steel Workers, the president of the American Federation of Labor, and by our working-class leaders."

In some of the recent disputes in these districts it has been found that the weight of opinion is against compulsory settlements.

"The men declare that the imposition of such conditions as are proposed by the State would be 'tantamount to slavery'; while the masters profess that under such schemes 'the government always forces the employer to yield, but never the employee.' The probabilities of the scheme getting through the congress, therefore, do not seem very strong. It is argued that, if an employer is compelled to pay wages which he is not willing to pay, this is confiscation, and that, if an employer is unwilling to keep his mines open or his works running at a certain profit, the government could not seize his works, since this would mean robbery. Each side seems convinced (at least they profess) that the only acceptable plan for the prevention of coal and iron trade and railway labor difficulties is to establish voluntary arbitration and conciliation, and to depend upon public sentiment to enforce its verdict. It is admitted that the State has the right, in cases of danger of an industrial conflict, to investigate concerning the causes, and, if possible, seek to prevent the stoppage of industry or commerce. The claim of the State, however, to compel masters or workmen to continue working under terms that neither, in the exercise of their independent judgment, are willing to accept, is being stoutly combated. Unfortunately, however, as matter of fact, arbitration, whether voluntary or compulsory, in labor disputes seems to lack any amount of enthusiasm in the Pennsylvania or any other of the American coalfields."

Last year an agreement was entered into between the Pittsburg coal owners and their men, comprising a uniform wages scale, and providing for arbitration in case of any deviation from the scale. A reduction threatened on one side led to threats of a strike on the other, and no serious attempt to arbitrate has been made. At the close of the strike in Massillon an arbitration resulted in a decision which the men refused to accept, declaring that the decision was not according to the evidence. All this indicates that arbitration, especially compulsory arbitration, is not popular with either employers or the employed on this side of the Atlantic.

Altruria.

An organization taking the name of the Altruria Association was founded in the spring of 1894. Mr. Edward Payne, in *The American Magazine of Civics*, gives an account of this society and its object and methods, and says that it has so far met with peculiar public favor in California and is beginning to attract attention throughout the country. This association has located its headquarters near Santa Rosa, Sonoma County, California.

"The organization is a fraternal order. Brotherhood is the corner-stone. The motive is mutual good-will. The merely selfish point of view is condemned. The service of all by each, and the service of each by all, is the balanced and comprehensive principle. And this upon the ground that man owes just this to man."

Money paid into its treasury is "not an investment upon which interest or dividends will be paid." The nominal membership fee is $50. It is explained that even this is not an investment, but is exacted because at present the society cannot proceed at all without it; and the abolition of any initiation fee whatever is contemplated at some future time, when the association shall find itself able "to receive people on the basis of their personal fitness, accepting what they can and will bestow voluntarily on the cause."

To establish an intimate relation between actual workers in the colony and outside sympathizers a series of councils has been instituted. Several subordinate councils already exist in various cities of California. There are recruiting agencies to the colony forces, and also educational institutions in their several communities. The members are not pledged to go to the colony, but may do so on certain conditions. If they do go, they enter Altruria Council No. 1, which is yet a subordinate and probationary council, on the working grounds. In this relation they remain for six months, sharing the work of the colony and all its privileges, except that they have no voice in the management of affairs. At the end of this period they may honorably withdraw, or may await the judgment of the Grand Council as to their fitness to remain. When received into the Grand Council, they are members for life, if they abide by the principles and regulations of the institution.

The aims of the Altruria Association are both economic and social. "The greater thought is to secure and maintain wholesome and happy relations in every respect, to make social life strong, beautiful, and sweet, and individual experience free, joyous, and noble." To this end all members are pledged to maintain a high standard of personal, domestic, and social morality. The intention to do active missionary work is announced, and it is stated that, as the society prospers, a large portion of its surplus will be set aside for the establishment and fostering of other settlements. These also are expected to become active propagandists, and thus it is hoped to prepare for the coming of "the real commonwealth, based on commonweal, that is to be." Various industries will be established. Each member, male or female, has an equal voice in selecting officers. Children, the sick, and the aged are to be cared for by an allowance from the common stock.

One seeks in vain in this exposition for any new principle of association on which to base an expectation of permanency. Similar organizations with the same ends and methods have time after time been formed, have lived out a brief term of anxious existence, and then have failed utterly. No such society has ever yet been able to realize its ideals; and, until human nature shall have been wholly regenerated, an association of this kind must inevitably fail, because success means renunciation of self on the part of each member, and individual devotion to the good of the whole. The nature of mankind has not yet reached this stage of evolution.

Desirability of an International Money Clearing-House.

THE ENGINEERING AND MINING JOURNAL (Feb. 16), under the title "The Gold Movement for Four Years," in a carefully-prepared table compares exportations of gold from the United States in excess of imports with the output from our gold mines, and finds an opportunity to introduce an argument for an international clearing-house as a measure of commercial economy. In 1891 the loss in gold over imports and production was $714,688; in 1892 there was a loss of $25,365,291; in 1893 we gained $29,477,297; and in 1894 we again lost $39.488,915. This does not include gold carried out of the country in a private way, of which the amount can only be guessed at, but which is certainly not an insignificant sum. The table, compiled from the report of the bureau of statistics of the United States treasury department, thus shows an aggregate loss for the 4 years of upwards of one-fourth the actual production of gold for the same time. Our contemporary estimates that the total taken out of the country privately would probably double the reduction indicated in the tabulated statistics. The Baring failure is thought to have accelerated this movement, which began in 1891. In 1893 the tide seemed to have turned in favor of the United States, only to be followed in 1894 by a larger exportation than ever before. An examination of this gold movement in all its phases leads to the conclusion that, "until our treasury is permanently removed from the banking business, and the conditions of trade cease to be dependent upon the action of the government, we will always be exposed to crises similar to that from which we are just escaping." With reference to the proposed international monetary clearing-house, we quote the following:

"The disturbance of trade by gold exports, the currency panic through which we passed last year, and that from which we have so narrowly escaped, would have been entirely averted,—or rather would not have been possible,—had the international monetary clearing-house system been in operation. The regulation of foreign exchanges and the prevention of such movements as we have recorded above, which would be accomplished by that system, would, we believe, in a few years produce so great an improvement that the commercial world would not only accept the system, but wonder why it had not been carried into practice long before. There is another point which is worth consideration. During the four years given in the table above the total movement of the yellow metal to and from this country amounted to over $493,000,000. The actual cost of handling and shipping this amount, with the other charges,—such as freight, interest, insurance, etc.,—amounted to a considerable sum, probably much more than would have been sufficient to pay all the necessary expenses of the international monetary clearing-house, so that the operations of such a commission would have shown an actual economy in the expenditure of money, in addition to the almost incalculable saving from its benefits to business generally."

Industrial Conditions in Central Europe.

THE over-stimulation of the manufacturing industries, which, according to *The Age of Steel* (Feb. 16), is the cause of industrial troubles in the United States, has, in the opinion of that journal, brought about the same state of things in Central Europe. But it is claimed that these conditions are even more pronounced in Europe than in America. "The policy of the countries of Central Europe has been, particularly for the past twenty years or more, to inflate their manufacturing industries indefinitely, instead of trying to maintain a healthy equilibrium between the agricultural and manufacturing interests, each as a national life force. Several of these Central Europe States have an established system of economic jugglery, whereby labor and industry are taxed for an export bounty on manufactures. The result has been to add largely to a previous adequate—or, perhaps, superabundant—supply of labor at manufacturing centers. As in this country, the ambitious bread-winners have turned their eyes and feet toward the great cities. The movement has glutted the urban labor market, and caused wages to fall to almost, if not quite the point of bare existence for the workers. Labor-saving machinery has aggravated the evil by increasing the number of idle, whose services are both statistically and actually available at cheap rates. In such circumstances, the manufacturing industries have made headway,—more rapidly so, when reasonably intelligent labor can be had for a song, comparatively speaking; and back of this order of things looking to the lowest practicable standard of living for the worker are huge military establishments for shooting holes through strikes and revolutions with equal impartiality and celerity."

Germany is noted for its low wages, particularly in the iron industries. These low wages and attendant industrial conditions also prevail in Belgium, and in the Grand Duchy of Luxembourg. "Wages in and about the mines in the Grand Duchy have increased in the following itemized way: laborers, from 54 cents a day in 1871, to 68 cents in 1894; surface miners, from 64 to 65 cents; miners in gallery, decrease from $1.10 to $1; drivers in gallery, unchanged at 80 cents; sorters, from 60 to 77 cents; rail-layers, from 60 to 81 cents; smiths and wheelwrights, from 75 to 87 cents. At the steel works, rolling mills, and blast furnaces of the Grand Duchy wages are correspondingly low, and, from the American standpoint, disproportionately so. The foreman of a steel works, for example, must thrive on $60 to $70 a month, and the assistant foreman on $1.18 a day. Converter hands, founders, basin hands, and converter machinists are each classified as first, second, and third, and are paid accordingly. Extreme wages range, for converter hands, from 73 cents to $1.07 a day; for founders, from 76 cents to $1.18; for basin hands, from 70 cents to $1.03 for the first-class. Ladlers receive 84 cents a day, ingot cleaners 52 cents, machinists 65 to 80 cents, cupola hands 60 cents. Rolling-mill and blast-furnace employees are paid in about the same proportion." The cost of clothing and rent is somewhat less than in the United States, but food costs as much or more than in this country, as will be seen by the following prices. Coal costs $7 per ton; eggs, 21 cents per dozen; rye flour, 3 cents per lb.; wheat flour, 5 cents per lb.; sugar, 8 cents per lb.; butter, 25 cents per lb.; beef, 19 cents per lb.; veal and mutton, 16 cents per lb.; fresh pork, 20 cents per lb.; and smoked pork, 23 cents per lb.

Profit-Sharing.

IN discussing editorially the subject of profit-sharing, and taking as a text a paper read by Mr. John L. Ketcham before the Indianapolis Literary Club, *The Iron Age* takes the ground that profit-sharing is not a panacea for existing labor troubles, and that, while it would be admittedly correct in theory were all the lazy, shiftless, suspicious, and discontented eliminated, as long as average human nature remains what it is the system can never be made to work according to theory, and in the large majority of cases it is certain to fail of its object. "The first instances in which it is successful, or apparently so, do not prove that other employers will find it beneficial to them. Such a scheme will flourish if all the conditions are favorable, and especially if the originator is gifted with a peculiar genius for philanthropic work, but not if it is entered upon as a cold, mechanical, mathematical business proposition. As well might the success of certain communities holding property in common be cited as proving that the true way of solving the problem of life is to form such communities everywhere. Innumerable unsuccessful efforts have been made to establish other communities, which were failures because the organizing talent was lacking. Other requirements are necessary than executive ability, and these requirements are not common."

Successful Profit Sharing.

AS opposed to the opinion above expressed, two examples of alleged success in profit sharing are cited by F. W. Blackmar in *The Forum* for March. The establishments named are the soap and candle manufactory of Proctor & Gamble at Ivorydale, Ohio, and the N. O. Nelson Manufacturing Company, manufacturers of machinery near St. Louis, Mo. The first-named establishment is large, employing a considerable proportion of unskilled laborers, and the average wages are $10 per week. The plan now in operation is the payment of 12 per cent. dividends on the common stock, provided this dividend is earned and after paying each member of the firm a salary of $4000. Fully 98 per cent. of the laborers are said to now participate in the profits, beginning to share after having been in the employ of the company for 3 months. If an employee quits work or is discharged before 3 months of service he does not share. Employees are encouraged to acquire portions of the capital stock. A pension fund is created by setting aside $500 annually for this purpose.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Industrial Sociology in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

29155. Credit and Trade (B M—Feb.) 1000 w.

29169. A Lesson of the Present Depression in the Iron Market. Charles Catlett (A M & I W—Feb. 8.) 900 w.

*29172. Revolutionary Legislation. T. W. Graham (Mill—Jan.) 1800 w.

*29226. Compulsory Arbitration in American Mining Districts. Anon. (C G—Feb. 1.) 1000 w.

We supply copies of these articles. See introductory.

29187. The Brooklyn Strike from a Financial Point of View. From the Brooklyn Eagle (S R G–Feb. 9.) 2000 w.

29265. Labor Arbitration in France. Charles W. Whiley, Jr. (R R–Feb. 9.) 1200 w.

29276. Prevention of Railroad Strikes. Recommendations of the New York State Board of Arbitration (Ir Age–Feb. 14.) 400 w.

†29282. Sidelights on Socialism. I. Belgian Socialism. H. G. Keene. II. Experiments by Colonization. Edward Salmon. III. Woman and Socialism. Karl Knödel (F R–Feb.) 12500 w.

†29283. Is Bimetalism a Delusion. Edward Tuck (N C–Feb.) 2800 w.

†29284. The Rural Revolution. Richard Heath (C R–Feb.) 7500 w.

†29285. The Evolution of Cities. Elisée Reclus (C R–Feb.) 10400 w.

†29286. The Voluntary Schools. James M. Wilson (C R–Feb.) 8400 w.

29317. The Gold Movement for Four Years. Editorial (E M J–Feb. 16.) 1100 w.

29372. An Easy Lesson.—True Money—What it Is. How to Make It Plenty. Edward Atkinson (T–Feb. 15) 2800 w.

29380. The Settlement of Differences. Frederick E. Goodrich (Boston Commonwealth–Feb. 16.) 1400 w.

29398. Central Europe Industrial and Labor Conditions. Editorial (A S–Feb. 16.) 800 w.

*29425. Railways and Voluntary Schools. Editorial (Ry T–Feb. 9.) 1200 w.

*29470. Russian Armenia and the Prospect for British Trade Therein. Anatolius Vladimirovich Markoff, with Discussion (J S A–Feb. 8.) 6800 w.

*29471. An Introduction to the Labor Question in the Colonies, America and Foreign Countries. Geoffrey Drage, with Discussion (J S A–Feb. 8) 18800 w.

*29533. New Unionism Reviewed (J G L–Feb. 12.) 2200 w.

*29554. Shall We Look Backward or Forward in Dealing with the Criminal? Henry Smith Williams (A M C–March.) 5700 w.

*29555. Money. James A. Quarles (A M C–March.) 8500 w.

*29556. Socialism and a Municipal Commonwealth. Lemuel C. Barnes (A M C–March.) 2700 w.

*29557. Do the Victors Own the Spoils? Ellis Biddle Reeves (A M C–March.) 2500 w.

*29558. Energy of Legislation. Edward P. Powell (A M C–March.) 2800 w.

*29559. Canada's Future as Seen by Canadians. Helen Gregory-Flesher (A M C–March.) 4000 w.

*29560. Are American Homes Decreasing? A Reply to J. A. Collins. Gilbert L. Eberhart (A M C–March.) 2800 w.

*29561. Education of the Farmer. Samuel James Logan (A M C–March.) 3000 w.

*29562. The Single Tax—A Reply to Arthur Kitson. R. W. Joslyn (A M C–March.) 2800 w.

*29563. Shall We Nationalize the Liquor Traffic? Mrs. A. L. Cornwall (A M C–March.) 2000 w.

*29633. Labor Questions. Editorial (E–Feb. 15.) 2000 w.

29648. The Public and Street Railway Strikes. William J. Richardson (S R G–Feb. 23.) 2200 w.

29660.—$1. Elected or Appointed Officials? A Canadian Question. J. G. Bourinot (An A A–March.) 10800 w.

29662.—$1. Terminology and the Sociological Conference. H. H. Powers. (An A A–March.) 4200 w.

29663.—$1. A Neglected Socialist. F. C. Clark (An A A–March.) 7500 w.

29664.—$1. The Organic Concept of Society. A. W. Small (An A A–March.) 3000 w.

29665.—$1. Sociology and the Abstract Sciences—The Origin of the Social Feelings. F. H. Giddings (An A A–March.) 3000 w.

†29740. A New Departure in English Taxation. Lord Playfair (N A R–March.) 2800 w.

†29741. The Future of Silver. R. P. Bland (N A R–March.) 2800 w.

†29742. How to Prevent Strikes and Lockouts. Stockton Bates (N A R–March.) 1700 w.

29743. Society and Strikes (S Ec–March.) 1500 w.

29744. The Free Coinage of Bonds (S Ec–March) 1800 w.

29745. The Single Tax Superstition (S Ec–March.) 3500 w.

*29752. Tariff Changes and Customs Regulations Russia, Sweden, Germany, Switzerland, France, Spain, Bulgaria, United States, Mexico, Brazil, Argentine Republic, Uruguay, Gambia, Mauritius (B T J–Feb.) 5000 w.

*29807. Prison Labor. Editorial (E–Feb. 22.) 3200 w.

*29909. Altruria. Edward B. Payne (A M C–Feb.) 1200 w.

*29910. The Business World vs. the Politicians. J. H. Eckels (F–March.) 2500 w.

*29911. Our Blundering Foreign Policy. H. C. Lodge (F–March.) 4000 w.

*29912. What Would I Do with the Tariff if I Were Czar? Andrew Carnegie (F–March.) 4000 w.

*29913. Is the Income Tax Constitutional and Just? E. R. A. Seligman (F–March.) 3500 w.

*29914. Two Examples of Successful Profit-Sharing. F. W. Blackmar (F–March) 4500 w.

*29916. The Tenement the Real Problem of Civilization. Jacob A. Riis (F–March.) 4800 w.

Serials.

28842. The Social Discontent. Henry Holt (F–Began Feb.—2 parts to date—30 cts. each).

29766. An Armory Against Socialism—Account of a Work by Dr. Flint (J G L–Began Feb. 19—Ended Feb. 26—2 parts—30 cts. each).

MARINE ENGINEERING

The Thompson & Marsden Recorder.

THIS ingenious, yet simple, device supplies means for settling disputes of a kind likely to occur in endeavoring to fix responsibility for collisions of ships. After these collisions, while officers who were on the bridge assert one thing, those who were on duty below are as apt to say another, each striving to shift the responsibility from themselves to others. *The Engineer* (Feb. 1), from which the illustrations given herewith have been reproduced, in commenting upon the necessity for a device of this kind, says: "We do not mean to say that in all cases there has been wanton lying, but we do mean to say that it would be very difficult for the most conscientious and scrupulous on both sides to agree on such a matter. Take a case where there is a man above and another below, each conscientiously jotting down the orders with their times, as they are delivered, on a slate, the clocks working together exactly,—unheard-of conditions,—we doubt if in ninety-nine cases out of a hundred in actual every-day practice the two tables thus compiled would correspond." It is said that the recorder illustrated in the engravings has been subjected to such long and severe tests that no doubt remains as to the claims made for its performance. "It records on a sheet of paper the time and duration of every order in such a way as to leave no possible doubt. It chiefly consists of a recording drum, on which a metallic pencil, actuated by the telegraph lever, presses, the movement of the pencil being parallel to the axis of the drum, which, for convenience's sake, is vertical. The drum revolves once in 12 hours, and each card lasts for that time, beginning at 8 A. M. Fig. 1 shows the divisions on the card of the hour into quarters, which are again subdivided into minutes. Let us take the instance of a ship getting under weigh in the forenoon watch. From the pencil path in Fig. 1 it is clear that the engineers got word to stand by at 6½ minutes past eight, and a minute later got the order for 'astern slow,' which lasted for two minutes, when they had to reverse and go ahead, and so on. The card thus tells its own tale, the vertical lines giving the orders, and the horizontal lines showing how long each order was in force without alteration. Thus any one can read the card at a glance. Fig. 2 shows the principle of the mechanism, the telegraph lever and pencil being at their respective positions for 'stand by ahead.' It will be seen from Fig. 2 that the pencil is held by a rack, which is raised or lowered, as the case may be, by a pinion receiving its motion from either the telegraph spindle or from the chains to the engine-room, which amounts to the same thing. Of course the recorder can be put anywhere on the bridge, or in the captain's cabin, or even in the engine-room, and it in no way interferes with the action of the indicators at present in ordinary use, being merely an accessory to them in the form of a silent and accurate witness and recorder of their every movement. It

Fig 1

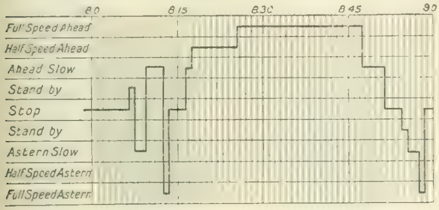
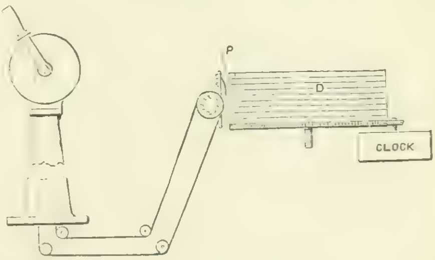


Fig. 2

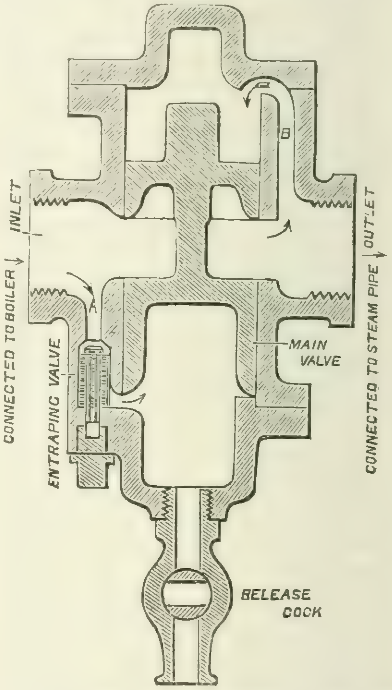


should be understood that the path delineated by the pencil in Fig. 1 is caused by the use of the telegraph lever when simply moved and not swung, as it most often is, to its extreme position on each side in order to give a louder and more decided ring on the bell, so that each order would be shown by what would really be a zig-zag, the angles of which would be so acute as to be invisible, the result being a thick, almost vertical line the entire height of the card."

It seems that the use of this device ought to obviate completely any such conflict of testimony as has hitherto obscured the real causes of collisions, and enable authorities to determine with certainty whether any fault was committed, and, if so, who committed it.

Steam-Pipe Safety-Valves.

THE inventor of this device is a citizen of Dublin. In our February number we noticed in this department the dangers attending explosions of steam pipes at sea, and some of the means proposed for their prevention. The device under present consideration was illustrated and described in *The Engineer* (London, Feb. 1), from which we have reproduced the engraving. The invention is intended to prevent the outrush of steam and loss of life which take place when a steam-pipe bursts in an engine room. "The principle involved is that so long as the steam flows at a moderate speed the valve will remain open. If the pipe bursts, the violent outrush closes the valve on the boiler at once. The valve is connected as close to the boiler as possible, and steam turned on, filling every part of it with steam of equal pressure; and, as the valves are of equal areas, there can be no movement, as the steam fills the space below the small valve—on the top—or between the heads of the double-headed valve and on the top; in this position every part is in equilibrium, and the weight of the valves keeps them down. In this position there is a full straight way from the inlet to the outlet side of the valve, and, as the opening through the valve is arranged to be equal in area to the pipe, there cannot be any obstruction. Should a pipe burst, or any other accident occur to suddenly release the steam and permit it to flow into the atmosphere, all the conditions are changed. This release of steam reduces the pressure above the small valve, which closes by the superior pressure of the entrapped steam. This steam, then expanding, closes or pushes up the double-headed valve, because the pressure is also reduced above the top head; and, as the orifice on the outlet side closes, the steam from the boiler banks up against the inlet side, thereby increasing the pressure until the small valve becomes unseated; then the full boiler pressure completes the closing of the outlet, and, the valve being shut off completely from the pipe, no steam can pass. The action of the valve is very rapid, but the extension on the top head of the valve and the recess in the top cover act as dashpot, plunger, and cylinder, in which a portion of the enclosed steam or vapor is entrapped, only escaping by reason of the looseness of fit or through a groove cut in either length of cylinder or plunger; consequently the action of shutting off is accomplished without shock or



noise. No spring is used. The valve has been carefully tried under various conditions, and found to work properly." The use of this device would, therefore, seem to wholly remove, or at least greatly lessen, the dangers attending explosions of steam pipes on shipboard, and will be likely to come widely into use unless some more simple means can be made to effect similar results.

The Four-Masted Ship Somali.

PREFACING it with a comment upon the present popularity of "large sailing ships with owners of that class of tonnage," and a partial list of large sailing vessels that have been built on this side of the Atlantic, the *American Shipbuilder* gives a description of the *Somali*, built by Russell & Company, Glasgow, which is said to be the largest four-masted ship ever built, and the largest carrier of any sailing vessel afloat to-day. There is a single vessel, the *France*, which has a larger registered tonnage, but she cannot carry so much cargo as the *Somali*. The following are the respective dimensions of these giant ships: "*France*, length, 361 ft.; beam, 48.8 ft.; depth, 25.9 ft.; registered tonnage, 3,624 tons. *Somali*, length, 329.9 ft.; beam, 47 ft.; depth, 27 ft.; registered tonnage, 3 336 tons. The *Somali* arrived at San Francisco last spring with the largest cargo ever brought to that port from Hongkong by a sailing vessel. It consisted of 2500 tons of coal and 2100 tons (measurement) of general merchandise. She has the largest steering apparatus ever placed on a sailing vessel. There are two steering wheels, at which four men stand in stormy weather. A brass spoke projects outward from the front wheel, and in exceptionally bad weather, when it is necessary to move the wheel quickly, a man is stationed at that, so that at times there are five men at the wheel. Under the wheel-box is a light box—the design of Captain Hannay—to carry a bright light, showing six points on either side, to prevent another vessel from running her jib-boom into the stern at night-time. On the poop is a teak chart-house with a companion way to the cabin; also a telephone, through which the officers of the watch can communicate with the captain in his state-room. The captain's state- and sleeping-rooms right aft, under the poop, are very spacious, finished in teak, mahogany, and bird's-eye maple, and upholstered in maroon plush. In the capacious lazarette are lockers, cemented, for private stores. The rooms are lofty and well lighted with a skylight and a number of port lights. Forward of the captain's quarters is the dining-saloon or mess-room, the officers' and steward's quarters, and a roomy sail-room. A flying bridge from the poop runs the whole length of the vessel. She carries a crew of thirty-eight, all told, including four apprentices. She has in the chocks two life-boats, a pinnace, a gig, and dingy. The steering compasses are placed 6 or 7 ft. forward of the wheels, so as not to be affected by the ironwork there, and on the top of the petty officers' house is located a standard compass fitted with two ball, soft-iron correctors. She has four capstans and ten bitts on the main deck, and four hatches with combings 36 in. high. Her three forward masts measure 208 ft. from deck to truck, the jigger mast 162 ft. Her spanker boom 47.6 ft., spanker gaff 36 ft., bowsprit 60 ft. from the knightheads out, and the lower yards 90 ft. in length. Her six top-gallant yards are each 70 ft. in length, and no ship afloat has such large ones. The wire rigging is set up by the biggest screws ever made in England, and the windlass is the largest one ever made in Glasgow. Her anchors weigh in the neighborhood of 3 tons each. In the engine-house is a centrifugal pump for pumping water for washing decks, condensing water, etc., and machinery for working, by means of a messenger chain, the pumps, hoisting sails and cargo, etc., and for working the windlass and capstans. When the condenser is working, the water can be run by a tube directly to the tanks. The forecastle, or sailors' quarters, located in a house forward, is well lighted and very spacious. The men have a nice bath-room under the forecastle deck, where are also located the oil and lamp rooms, and where is kept a patent fog-horn, a Norwegian invention worked by a crank and bellows, which, when turned, emits a weird, unearthly sound. The boys' quarters aft are fitted up better than the cabins in many vessels. Mr. Morgan, the chief officer, a young man only 27 years old, was in command of the vessel when she was dismasted near Ilo Ilo. Capt. Hannay says that the *Somali* loaded in San Francisco 5700 tons of wheat on a draught of 23 ft. with a freeboard of 6 ft. 8 in."

A Gas-Engine Propelled Barge.

"L'Idée" is the name of a new French barge propelled by gas-power, being one of a line of such barges which will ply between Havre, Rouen, and Paris. The vessel is described in *Industries and Iron* (Feb. 1). The engine was designed by Messrs. Delmare-Deboutteville and Malandin. As far back as 1883 these two gentlemen constructed a tricycle operated by a gas-engine, which was actuated by gas compressed to 22 lbs. per sq. centimeter in two copper cylinders, and it was decided to make a similar experiment, but on a more extensive scale, in the case of barges for the Seine.

The gas for the barge engine is ordinary illuminating gas compressed into steel tubes to 220 lbs. per sq. in. The engine is of the vertical type. The barge is constructed of iron: "Length, 98½ ft., breadth, 18 ft., and draft, 7 ft. 4½ in. The vessel is divided into four watertight compartments. In the front compartment, in the bow of the vessel, are situated the captain's and the crew's compartments. The two middle compartments, extending about four-fifths of the whole length of the vessel, form two large holds, the engine being situated in the compartment at the stern. The vessel has a gross register tonnage of 300, while, having regard to the small space taken up by the crew's quarters and the engine, a cargo of 250 tons may be transported by the vessel. The rudder has a large afterpiece, and is operated by means of chains and a wheel, arrangements being provided for fixing the rudder in any position without the necessity of the wheel being held by the man at the wheel. The steel tubes, forged from a single piece, have an outside diameter of 9.84 in., a thickness of 3.1 in., and a length of 16.4 ft. Each tube weighs 715 lbs., and will contain 22 cubic meters of gas, at a pressure of 350 lbs. The tubes, of which there are altogether eighty, are connected together by flexible joints, similar to those used by the compressed oxygen companies in England and America. The joints have been tested to above the pressure to which they are subjected in actual working, while, to prevent accident, and also to economize space, the battery of tubes has been placed on the captain's bridge, from which on its passage to the engine the gas is expanded to the desired pressure in a special apparatus. Should an escape of gas, therefore, occur, there will be no danger, as the escaping gas will pass off directly into the air."

The engine is a "Simplex" of the vertical two-cylinder type, and drives a McGlasson two-bladed reversible propeller. The connection of the engine with the propeller shaft from the cranks (set at right angles) is made by flexible couplings in such manner that the engine may be disconnected at pleasure from the shaft. The gas, first entering an expanding apparatus, is mixed with air in a special mixing chamber before its induction into the cylinders. Several trials of the efficiency of the engines have been made. With a load of 145 tons, 7½ miles per hour were attained on one occasion over a distance of 45 miles.

An Electric Rudder.

A curious application of electricity to steering boats is described in *The Electrical Engineer* (Feb. 8). The boat is propelled by twin screws, and the apparatus is so constructed as not only to drive the boat, but, under proper direction, to steer it as well. The illustrations (not available for this review) are necessary to give a complete understanding of the ingenious way in which this invention is worked out, and the device can only be mentioned here as an innovation likely to come into wide use for electrically-propelled launches yachts, etc., when its merits shall have been proved by use. Our contemporary states that one of these motors is at present on view at the yachting exhibition of the London Aquarium. It is claimed that, when fully charged, this motor is competent to propel a boat carrying four persons, in still water, at the rate of from 4 to 5 miles per hour continuously for 8 hours. It is anticipated that this motor will be widely used as a substitute for oars in pleasure-boats let for hire at watering-places and pleasure-resorts, since its construction permits it to be adapted to all row-boats without material alterations.

ENGLISH Government docks appear to have been unable to compete with outside builders in engine construction. It is now announced that no more engine building will be done in them. *Industries and Iron* says that the three chief yards—Portsmouth, Chatham, and Devonport—have had repeated trials, and the local officers themselves are obliged to confess that in neither speed nor economy can they compete with outside makers. The explanation they offer is lack of suitable plant, that which they have, although fitted for repairs, being insufficient for construction. From Devonport especially the decision is regretted, as this class of work was found to provide excellent practical instruction for the students at the Engineering College.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Marine Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*29150. Lessons of the Elbe Disaster. Robert Gillham (E Mag–April.) 2000 w.

*29179. The Cost of the French Navy. Anon. (E–Feb. 1.) 1600 w.

*29180. Transatlantic Passengers (E–Feb. 1.) 1000 w.

*29213. Sir Edward Harland on British Warships (S L–Feb.) 800 w.

*29214. Launch of a New Cunarder—The "Sylvania" (S L–Feb.) 900 w.

*29230. Steam Pipe Safety Valve. Ill. Invention of J. Batey (Eng L–Feb. 1.) 400 w.

*29232. The Machinery of Our Ships of War. Editorial (Eng L–Feb. 1.) 1600 w.

*29277. The Thomson and Marsden Recorder. Ill. (Eng L–Feb. 1.) 600 w.

*29315. Nine Years of the World's Mercantile Shipbuilding (M E–Feb. 1.) 800 w.

29322. "La Gascogne's" Mishap. Ill. (E R–Feb. 16.) 800 w.

29342. The United States Frigate "Constitution." Ill. (Am S–Feb. 14.) 800 w.

*29411. The New Mayne Electric Rudder Motor. Ill. (E E L–Feb. 8.) 800 w.

*29418. Early Atlantic Steamers. Ill. From the Glasgow Herald (E–Feb. 8.) 1800 w.

*29459. Galway as a Transatlantic Port (Tr –Feb. 8.) 600 w.

*29463. The Elbe Disaster. Editorial (Eng L–Feb. 8.) 1900 w.

29496. The First Pacific Built Whaleback Steamship. Ill. (Sea–Feb. 21.) 800 w.

29497. Defending Protection for Agricultural Products. David Lubin, with Editorial (Sea–Feb. 21.) 2500 w.

29504. The Piston of the Gascogne Was Fractured. Ill. (S V–Feb. 15.) 1500 w.

29505. Steam Lifeboats. Ill. (S V–Feb. 15.) 1200 w.

*29528. Water Tube Boilers for Marine Purposes. Ill. William F. Durand (S J E–Feb.) 5500 w.

29564. The Four-Masted Ship Somali. Ill. (Am S–Feb. 21) 600 w.

*29592. Spontaneous Combustion of Coa Cargoes (F'y–Feb. 15.) 1300 w.

*29644. The Gas Engine Propeller Barge "L'Idee." Ill. (I & I–Feb. 1.) 1200 w.

29746.—$1.25. Contract Trial of the United States Armored Cruiser "Maine." Ill. A. W. Morley (J A N E–Feb.) 7200 w.

29747.—$1.25. Tests of the Boilers of the Steam Yacht "Wild Duck." Ill. Ira N. Hollis (J A N E–Feb.) 4800 w.

29748.—$1 25. Water Tube Boilers. Nabor Soliani (J A N E–Feb) 12000 w.

29749.—$1.25. Partial Collapse of a Corrugated Furnace Flue. Ill. Charles H. Hayes (J A N E–Feb.) 300 w.

29757. Threatened by a Flower.—A Water Hyacinth That Grows so Rapidly as to Impede Navigation (B J C–March 2.) 1400 w.

*29810. The Yachting Exhibition. Editorial (E–Feb. 22.) 2700 w.

*29849. The Rule of the Road at Sea. P. H. Colomb, with Discussion (J S A–Feb. 22.) 9000 w.

29869. The Beacon Tower of the Plateau of Horaine. Ill. (Sc A.S–March 9.) 1100 w.

Serials.

16636. Marine Engine Design. Ill. (M W –Began Sept. 29, 1893—21 parts to date—30 cts. each).

29295. Graphic Analysis of Paddle Wheels with Fixed and with Feathering Floats. Ill. Charles M. Jones (A M–Began Feb. 14—2 parts to date—15 cts. each).

29341. Classification of Lake and Ocean Vessels. Joseph R. Oldham (Am S–Began Feb. 14—Ended Feb. 28—3 parts—15 cts. each).

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Sewage Water for Steam-Engine Use.

In the department of Municipal Engineering for this month will be found a review of a process of purification of sewage by aeration, which has been made the subject of experiment at St. Louis. It having been stated therein that the value of this process had been questioned in high quarters, it seems proper to say that at least a partial confirmation of the value of aeration has come from abroad, in a paper contributed to the *Journal of the Sanitary Institute*, and reprinted in *Industries and Iron* (Feb. 8). In this paper an account was given of an attempt to use sewage water for steam-engine purposes. The writer, Alderman Norton, states that mineral matters in sewage water used for steam production are all precipitated, and do not form a hard scale, and that, therefore, incrustation of boilers does not occur in their use. The intolerable nuisance caused by the odor may be obviated. Mr. Norton describes the way in which he was led to experiment with sewage water for steam-engine use as follows:

"I was led to the consideration of this question from the fact that the Palm Mill, of which company I am chairman, occupied a site on the lowest confines of the town. There was a small reservoir on the property, which was fed by a stream which had practically become a sewer for the town; the supply of water was apparently so abundant that we thought we could use it for condensing purposes and let it pass, but a dry summer proved we could not depend upon it without impounding it and using it over again; then the stench became a nuisance, and we were obliged either to make a larger reservoir, costing from £2000 to £3000, or to find a means of making the water innoxious. In order to do this, we built a large cooler, which has since been extended. We did this because I thought it would serve a double purpose of oxidizing the water as well as cooling it, and destroying the nuisance while preserving valuable water. The cooler was built for 2000 h. p., and is 90 ft. long, 24 ft. wide, and 20 ft. high; the water is raised from a hot well by two centrifugal pumps to the top of the cooler, and conveyed in the middle to its whole length by a large trough. This trough has one hundred and forty holes in it, distributing the water into one hundred and forty narrow troughs that are laid the width of the cooler. These are laid perfectly level, the overflow descending in the form of rain onto a lattice bed 2 ft. below, and from that to other lattice beds 2 ft. apart, the whole descending into a small reservoir in the mill yard, and being re-conveyed to the larger reservoir in a cool state. The reservoir, which was originally intended for 150 h. p., is simply used for storing water. The cooler takes about 42 deg. of heat out of the water, varying somewhat in cold and windy weather. From observations we have taken, we find that the cooler requires twice as much water as a reservoir, a considerable quantity being evaporated in steam; but, as we have an abundant supply, the loss is made good by introducing a fresh supply."

Mr. Norton asserts, as conclusions drawn from results of these experiments, that the water falling in the form of rain through the air is changed in character, and that the reservoir, instead of containing a mass of foul, offensive matter, becomes innocuous and comparatively pure. "By descending in innumerable drops, the oxygen of the atmosphere attacks the gas with the following results: the oxygen combines with the sulphur and forms sulphurous or sulphuric acid. It also combines with the freed hydrogen and forms water. The alkaline matter in the water neutralizes the acid, with the result that in the last operation the offensive odor is completely destroyed. That this is the true solution of the operation is proved by the fact that in London the sewage is treated chemically with sulphuric acid and permanganate of potash, which virtually performs the same operation."

The establishment is said by Mr. Norton to be using about 2000 h. p. at the present time. The cost of the cooler, pumps, and pipes will not exceed £600. The cost of running the plant, inclusive of deterioration, is £26 per annum. The water, 93.300 gals. per hour, has to be pumped to a height of 20 ft. The water, however, is comparatively clean, having in its course been freed of a great part of its undissolved solid matter. The reservoir only accumulated 5 in. of solid matter in the bottom during 6 months' use. Mr. Norton states that Palm Mill now has the advantage of using water that costs nothing, and which is, after the treatment described, of superior quality for raising steam,—giving no boiler incrustation whatever. But his observations do not much favor the project of permanent purification by aeration. He says that, if the water be allowed to stand exposed about a week, it gets foul again, though, if kept in stoppered bottles, it will show no signs of putrefaction ; and he thinks the prevention of secondary putrefaction after the treatment would require the water to be filtered through sand or earth.

Effect of Temperature on Indicator Springs.

According to a writer in the *Bulletin de la Société Industrielle de Mulhouse*, quoted in *The Practical Engineer*, an indicator spring may be carefully tested, yet the reading will not be the same, " because certain portions of the spiral only come into play with certain loads, and thus the reading of the scale may vary considerably. In transmitting movement to the pencil, the chief object seems hitherto to have been to make the pencil trace a straight line instead of registering the delicate oscillations of the spring." It is not made clear how it is that certain parts of a spiral spring act only when a coiled spring is compressed, unless " certain parts " means *all* parts. This proposition conflicts with principles and formulæ laid down by standard authorities on mechanics.

The author also thinks that the effect of temperature upon the reading ought not to be overlooked. To determine the effect of temperature, he " tested the same spring with the same loads, but at different temperatures, which were measured by a thermometer inside the indicator cylinder. Although the thermometer was separated from the spring by the indicator piston, the temperature, owing to the conductivity of the metal, was practically uniform. By means of a current of hot air it was raised above 212° F., a temperature which he believes is never attained during an engine test, seeing the short time the indicator is in contact with the steam, and considering the large radiating surfaces which carry off the heat. The author proves by calculation that the flexibility of indicator springs increases in a given proportion with each degree of rise in temperature. The chief difficulty in making these experiments is to determine the actual temperature of the spring at the moment of testing. This temperature once ascertained, accuracy can be secured, provided a sufficiently large number of observations are made. The author, however, considers it sufficient in ordinary trials to test the springs cold, the resulting error being not more than 1½ per cent. to 2 per cent. This is compensated by the unavoidable errors in transmitting the variations in pressure on the piston of the engine to the indicator."

Here, again, there is room for the criticism that, if the resulting error is so small that it is compensated by the errors in transmitting the variations in pressure on the piston of the engine to the piston of the indicator, and if, therefore, in practice, the error due to temperature of the spring may be disregarded, the effect of temperature is only of theoretical interest. The method of testing springs which the author used in his experiments is, however, good and practical. For this purpose he " divided the load into a certain number of equal parts, to each of which a line corresponded. The spaces between these lines should be practically the same. Errors due to friction of the spring were obviated by shaking the indicator each time before it traced a line. Two lines were drawn for each pressure, and the mean of the two taken. As, however, a spring, when released, may not return at once to its former position, but be accidentally deflected for a time, and the error pass unnoticed, the following precaution was adopted: the positions of the pencil as the load increased were verified until the limit of weight had been attained; the spring was then gradually unloaded and tested in the reverse direction." The mean of the readings thus obtained ought, in the author's opinion, to neutralize the effects of any disturbance in the spring while the indicator was at work. He states that, with a skilful operator, the error should be less than 0.1 per cent.

Factor of Stiffness.

MR. F. A. HALSEY, in *American Machinist* (Feb. 14), advocates a departure from the use of factor of safety in machine-designing, and the adoption instead of a "factor of stiffness." He maintains, with some force, that in designing machinery it is not enough in most cases that there should be sufficient strength in the parts to withstand the strains they are destined to receive; they should also have such stiffness that they will not yield injuriously under strains; and he holds that under the usual allowance, called the "factor of safety," insufficient rigidity is a common result. "The fact is—and it is time it were recognized—that all that mathematical analysis can do in these matters is to give the form of the desired formulæ, and any attempt to determine the various constants, factor of safety, etc., from a preconceived idea of the requirements is futile. The only way of arriving at values for such constants is by consulting and averaging successful experience. A fundamental error of conception is involved in introducing a factor of safety as such at all. Bridges and roofs are designed to carry their loads with safety, and that is all that is required of them. The deflection under the load, while a matter of interest, is of very slight practical moment, but in machine construction the deflection is an all-important question. Not many shafts break from lack of strength, but a great many of them run hot because of insufficient stiffness. In point of fact, the factors of safety in many machine-parts are so great as to be almost ludicrous, if considered as such; but, considered as factors of stiffness, their magnitude becomes rational and clear. In some machine-parts the question of stiffness is of relatively small moment, and in such the factor becomes reduced to a figure where it may with some reason be called a factor of safety; but in others, where rigidity as near absolute as possible is desired, the factor introduced is so great as to lose all semblance to a factor of safety. Considered in the usual manner, such differences are simply anomalous, and from no point of view, except the one presented here, can they be explained in a rational manner."

Discussing the strains to which engine-frames are subjected, no general treatment is found possible on account of the great variety of types. The Corliss type is selected as easy to examine and compare, and from data collected from measurements of engines of different build east of the Mississippi river, the following figures are given as the strain per square inch to which the smallest part of the frame (cross-section immediately back of the pillow-clock) is subjected. For engines of the following sizes: 10 in. × 30 in., 28 in. × 36 in., 18 in. × 42 in., 24 in. × 48 in., 28 in. × 48 in., and 30 in. × 60 in., the strains are, per square inch of this cross-section, respectively 217 lbs., 248 lbs., 278 lbs., 360 lbs., 296 lbs., 575 lbs., and 350 lbs. "Other data of a more miscellaneous character show loads of about 300 lbs. on short-stroke engines of about 10 in. diameter of cylinder, while one memorandum of a 32-in. engine which has been running for many years without any indication of weakness gives a strain of 667 lbs."

From these data the rule is formulated that in "engines of moderate speed, and having strokes up to one and one-half times the diameter of the cylinder, the load per square inch of smallest section should be for a 10-in. engine 300 lbs., which figure should be increased for larger bores up to 500 lbs. for a 30-in. cylinder of same relative stroke. For high speeds or for longer strokes the load per square inch should be reduced in accordance with that final resource in all engineering,—good judgment." It is frankly admitted that these data are not sufficiently comprehensive and definite "to satisfy the over-nice in such matters." The figures are, as factors of safety, "simply absurd, but are intelligible as factors of stiffness." They illustrate well, however, the point made by this writer.

Fly-Wheel Accidents.

THE increase of speed at which engines are run has popularly been supposed to have increased the number of accidents with fly-wheels. Not many years ago the bursting of a fly-wheel was comparatively a rare occurrence. According to a correspondent ("Observer") of *The Boston Journal of Commerce*, there were 13 accidents with fly-wheels in 1892, 12 in 1893, and 6 in 1894 up to September 1. The property loss resulting from these casualties, a list of which is given, is named in only a few out of the thirty-odd accidents listed. The lowest damage named is $10,000, and the highest $40,000. A number of lives were lost, and injuries were sustained by some who were fortunate enough to escape with life. The list is not claimed to be fairly complete except for 1892-3. Probably the number given as occurring in 1894 up to September does not include all the accidents to fly-wheels that occurred during that interval.

These accidents occurred mostly with large fly-wheels, upon which "Observer" remarks that "the difficulty of making large wheels strong enough for the conditions imposed in many kinds of modern service are so great that they seem to be most easily met by not making the wheels so large, and there is considerable testimony in favor of the high-speed small-diameter wheels, such as are now so extensively used."

To sustain this view a fly-wheel accident which occurred a few years ago on a Westinghouse 330-h. p. engine, driving a 3000-light dynamo, is cited. "Lightning wrecked the armature, wedging it into the field and stopping it instantly; the belt failed to go off, and by its grip checked the rim of the engine-wheel, ripping off all the spokes, while the wheel, which weighed about 5000 lbs. and was about 8 ft. in diameter, was running at two hundred and fifty revolutions per minute. The general shock of the disaster upset the valve gear, and caused the engine to run away, injuring it considerably, but the rim of this wheel rattled around on the shaft and floor, broke the remnants of the spokes, and came to a standstill without a crack. It was probably not made of any remarkable metal, nor did it have any favorable conditions to save it. It, however, had the virtue of being small and strong. Many a large wheel has gone to pieces under much less provocation than this wheel resisted."

It is pointed out that these accidents are chiefly taking place with new, rather than with old, engines; that the engines suffering them are chiefly in variable load service (especially in street-railway service); that they are "confined almost exclusively to slow-speed designs and a few moderate-speed engines; that high-speed engines are practically exempt from such accidents; and that it is becoming a matter of monthly record that engines of the type requiring large wheels are dangerous under the service of suddenly variable load. Their weakness seems to lie inherently both in the wheel structure and in the insufficiency of controlling devices common to such engines." The cause last assigned is probably as potent a factor in fly-wheel failures as the insufficient strength of wheels. There seems an imperative necessity for some device that will automatically close the throttle-valve whenever the speed reaches a prescribed maximum, slightly beyond the normal limit, but yet well within the limit of safety. In another review in this department it will be seen that the electrical governing of engines is now and has been for some time a matter of study, and probably in this agent—by which power may be transmitted more rapidly than by any other known—will yet be found the solution of the problem of steam-engine regulation under variable loads.

The Care of Wire Ropes.

Wire ropes, large or small, now enter into so many mechanical constructions that any addition to knowledge which applies to their care and preservation is important. Mr. John H. Janeway, of Trenton, N. J., has contributed an article on this subject to *The Colliery Engineer*, which is evidently based on a thorough knowledge of wire rope and its uses. He says: "There are many users of wire rope who either shut their eyes to the disastrous effects of friction, or else use materials to modify them which cannot give the desired results with the conditions under which they labor; and they gradually become accustomed to a state of affairs with regard to their wire ropes which ill accords with the general excellency of their other machinery. A wire rope should be considered a machine of many parts, and cared for as such. The necessity of lubricating each wire of a rope (there are from forty-two to one hundred and fourteen in the standard makes) can be easily appreciated when it is understood that they all change their relative positions to each other whenever the rope is bent.

"With a heavy tension on it, the wires grind upon each other, unless oiled. When passing around sheaves or rollers, unless the rope is well coated on the outside, that part will wear very fast. The problem is extremely simple in many cases, particularly in hoists free from water, where nearly any lubricant may be used without fear of its being washed or stripped off. Under other conditions, it is more difficult and complicated."

The lubricant used for a wire rope "must penetrate between all the wires, covering each with a thin film. As a preservative, it must prevent rust, and be free from acids. As a protection, it should turn water and other liquids, and form more or less of a cushion to prevent abrasion." A lubricant specially made to meet all the trying *conditions* to which wire ropes are subjected is now supplied by John A. Roebling Sons Company, but any one who pleases can make it. It consists of tar, summer oil, and mica axle grease, in such proportions as will meet the special conditions under which the ropes are to be used. "The tar and oil must be free from acid. This combination thoroughly penetrates between the wires, prevents rust, and fills the cable, so that it has the appearance of a bar of iron. It sheds water successfully, and does not strip off. Old cables which have been treated with this, when taken apart, show every wire bright and clean, the heart or hemp core being also in prime condition. Linseed oil, on the contrary, frequently hardens around the core, so that it rots and breaks down, destroying the cushion, which the hemp center ought to provide. As soon as the rope has been well filled with this compound, the addition of a very little from time to time keeps it in good condition, so that it is economical besides. The Roeblings state that it costs, in some cases they know of, one-eighth as much per year as the old materials, with far better results. The best manner of applying it is by means of a drip, which pours it on in a fine stream while the rope is in use, care being taken to put it on very slowly."

Electrical Regulation of Steam Engines.

At the Institution of Civil Engineers, London, a paper on "Regulation of Steam Engines" was recently read by Mr. John Richardson of Lincoln. So far as this paper, an abstract of which is printed in *The Iron and Coal Trade Review* (Feb. 8), relates to mechanical regulation, it appears to advance no ideas beyond those very thoroughly treated by preceding writers, going over about the same ground that is covered—though less thoroughly—by Mr. H. J. Conant in his paper, "The Ideal Steam-Engine Governor," printed in this magazine for October, 1894. What Mr. Richardson says with reference to electrical governing is of greater present interest, as there can be little doubt that electricity, ere long, will come to the front in engine-governing as it has done in so many other important applications.

"The conditions which obtain for an engine driving a dynamo are not quite the same as those for maintaining a constant speed of other machinery; as, if the electric current produced by the engine were used to control its speed, it becomes possible either to run the engine at a practically uniform speed in connection with a perfectly-compounded dynamo, or to run it at a varying speed, maintaining either a constant difference of potential with a varying current or a constant current. Further, it was shown that by utilizing the changes in the current to control the engine, it is possible when the load is suddenly decreased to effect what is impossible with a speed governor,—namely, to shut off for a time the whole of the steam supply before the engine has had an opportunity of increasing its speed. A number of appliances which have been devised during the last fifteen years and tested for electrical regulation were described, some as examples of what should be avoided and others as successful. In most of these latter a solenoid, the core of which is held in a varying position within it by the current, is connected in different ways to the valves. Two forms of electric motors for altering the position of valves were also shown, and other forms of relays. The advantage of the direct connection of the solenoid over any form of relay appears to be very great."

The paper concludes with a description of a method of "electric control of a valve-gear suitable for engines of large size, the power required to govern the lever being practically nil, a small solenoid and a slight current being found sufficient to effect the entire control of engines up to 1000 h. p. An automatic method of stopping or slowing the engine, should there be an accidental breaking of the governor circuit, was also discussed."

Sawing Stone by Wind-Power.

AN account is given in *Stone* for February of what is believed to be the only mill in North America that uses wind-power for sawing stone. This mill—the property of John Kline, Jr.—is located at Halifax, Nova Scotia, and the owner, at the request of *Stone*, has supplied the data for the description. His principal reason for adopting wind-power in preference to any other motive power was "that fuel is quite expensive in Nova Scotia, notwithstanding it is a coal-producing country." Another reason was that "with this power he could let his mill run windy nights with less attention, the wind in that region being of a more uniformly steady character than in the lower countries of the temperate zone. Thus a material saving is effected over steam-power, and a larger production is assured. The wheel adopted is 16 ft. in diameter. It runs a gang of three blades in excellent shape under a light breeze. Mr. Kline figures out a positive saving over steam of $3.00 a day, not counting his saving in labor; and the mill is yet an experimental one in the application of the most modern machinery for sawing stone. The mill is set to saw 1 1½ in. per hour in granite, and it is said to be doing the work splendidly. It is guaranteed to furnish sufficient power under an ordinary wind—say one of 5 to 8 miles an hour in velocity,—to cut 3 in. an hour in the hardest granite, using crushed steel for feed to the saws. The machine works true, and is under regulation to any speed desired in any wind less than a tempest." It is editorially added that Mr. Kline intends to equip his wind-power mill with the latest improved machinery, and to test the full capacity of the wind-mill in working stone.

Simplon Tunnel Ventilating Fans.

AN illustrated description of these great fans is given in *The Engineer* (Feb. 1), abstracted from the specifications of the Simplon Tunnel Company. "Not only will air be required for the workmen and for clearing away the gases generated by the locomotives, or in blasting, but the contractors rely on the constant circulation of large volumes of fresh air to lower the temperature in the centre of the tunnel to a degree at which the work can be carried on without inconvenience. The fact that the rock-drills are driven by water instead of by compressed air renders an independent air-supply even more imperative." There will be two fans at the end of the tunnel, either of which may be used to draw air out of the tunnel or force air in. Of course, while one is forcing air in, the other may draw air out. thus enabling the blowers to act materially in effecting a rapid change of air in the tunnel. When they work together to force air into the tunnel, they can deliver double the quantity at the same pressure or the same quantity at double the pressure. These fan-blowers are each 18 ft. in diameter, and each capable of delivering into or drawing out of the tunnel 1750 cubic ft. of air per second (6,300,000 ft. per hour) under a pressure of 9.75 in. of water. When acting together, they can deliver the same quantity at 19.5 in. of water pressure, or they can deliver 3500 cubic ft. per second at the first-named pressure,—that is, 12,600,000 cubic ft. per hour. The blowers of each pair will be arranged one behind the other, and provided with masonry flues and valves whereby to effect the described changes in action. The plant is not yet erected at the ends of the tunnel, but one of the fans has, it is said, been tested with results that assure their capacity to meet the requirements. The fans are made of wrought-iron plates with channel-iron arms and cast-iron naves. Very few if any fan blowers of larger size than these have ever been installed, and their construction and arrangement are instructive models for large ventilating operations.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

The Machine Shop.

*29776. Mast Traveller for Erecting Heavy Work. Ill. James F. Hobart (A E R J–March.) 1000 w.

*29818. Machine Tool-Making at the Atlas Works, Glasgow. Ill. (Eng L–Feb. 22.) 1000 w.

29865. Modern Machine Shop Practice. C. R. Tompkins (A S–March 2.) 1300 w.

29870. Gumming the Patternmakers' Saw. John M. Richardson (A M–March 7.) 1800 w.

Steam Engineering.

*29210. Effect of Temperature on Indicator Springs. Anon. (P Eng–Feb. 1.) 600 w.

29246. Steam Engine Economy. P. Batty (C Eng–Feb.) 1700 w.

29247. Water in the Boilers. W. Sutton (C Eng–Feb.) 1800 w.

29296. Rules for Engine Proportions. F. A. Halsey (A M–Feb. 14.) 1000 w.

29362. Fly-Wheel Accidents.—A List of Large Engine Failures. Observer (B J C–Feb. 16.) 1500 w.

29403. The Willans Law. W. E. Burgess (E E–Feb.) 1100 w.

*29421. Governing Steam Engines by Throttling and by Variable Expansion. H. Riall Sankey (I & I–Feb. 8.) 8500 w.

*29464. The Purification of Sewage Water for its Use for Steam and Condensing Purposes. Alderman Noton (I & I–Feb. 8.) 1600 w.

*29483. The Mechanical and Electrical Regulation of Steam Engines. (Abstract.) John Richardson (I C T–Feb. 8.) 1100 w.

29503. The Schmidt Motor. Ill. (S V–Feb. 15.) 2400 w.

29535. A Comparison of Boilers.—Merits of Various Types. Thomas Hawley (B J C–Feb. 23.) 3000 w.

*29624. The Straining of Boilers. Editorial (P Eng–Feb. 15.) 1000 w.

*29642. Priming and Governing Engines. Editorial (Eng L–Feb. 15.) 1900 w.

29678. Safety Valves and Other Safety Devices. D. Rivers (S E–Feb.) 2300 w.

29680. To Obtain Smokeless Combustion. J. Bowe (S E–Feb.) 3600 w.

29692. Testing Flue Gases. Ill. W. H. Booth (A M–Feb. 28.) 900 w.

29694. The Flow of Steam in Pipes. William Cox (A M–Feb. 28.) 1200 w.

*29819. High Duty Pumping Engines. Editorial (Eng L–Feb. 22.) 1900 w.

*29858. Margins of Safety in American Boiler Practice. Editorial (P Eng–Feb. 22.) 900 w.

*29860. The Economical Development of Mill Engines. J. Mills (P Eng–Feb. 22.) 2800 w.

29870. Free Expansion. George I. Rockwood (A M–March 7.) 1700 w.

29885. A Petroleum Heating Apparatus. Leemann-Baumgartner System. Ill. (Ir Age–March 7.) 2200 w.

29890. Entropy. R. C. Carpenter (Pr–March.) 1800 w.

29897. Proper Methods of Steam Piping. Ill. Frederick Fosdick (M A–March.) 1800 w.

Miscellany.

*29173. Notes on Power and Power Attachments. Anon. (Mill–Jan.) 2000 w.

*29190. The Care of Wire Ropes. John H. Janeway, Jr. (C E–Feb.) 700 w.

*29204. Manufacture of Brass and Bronze Goods. James Powell (The Ohio Valley Industrial Review of Jan.) 1200 w.

*29233. Ventilating Fans for the Simplon Tunnel. Ill. (Eng L–Feb. 1.) 500 w.

*29255. Sawing Stone by Wind Power. Ill. (S–Feb.) 700 w.

29294. The Proposed New Standard Screw Thread—Views of Firms, Mechanics and Others (A M–Feb. 14.) 3000 w.

29297. Drop Hammer Foundations. Carl Norland (A M–Feb. 14.) 2800 w.

29388. The History of the Bate Refrigerator Case and the Probable Effects of the Decision. W. B. Vansize (E R N Y–Feb. 20) 1100 w.

*29435. Experiments on the Strength of Copper. A. Martens (P Eng–Feb. 8.) 1200 w.

*29436. Welded Steel Steam Pipes. Warren E. Hill (P Eng–Feb. 8.) 1200 w.

29506. The Handling of Coal and Ashes at the Third District Station of the Edison Electric Illuminating Company, Brooklyn. Ill. (W E–Feb. 23.) 700 w.

*29509. Blowing Fans. Ill. Souffleur (M W–Feb. 15.) 700 w.

*29529. The Second Law of Thermodynamics. R. H. Thurston (S J E–Feb.) 4600 w.

†29688. Wellner's Sail Wheel Flying Machine. Ill. Helene Bonfort (P S M–March.) 2500 w.

29690. Weight and Mass. Charles T. Porter (A M–Feb. 28.) 1400 w.

29693. About Reheating Compressed Air. Frank Richards (A M–Feb. 28.) 2000 w.

*29821. New Elswick Eight-Inch Quick-Firing Gun. Ill. (Eng L–Feb. 22.) 2000 w.

*29877. The Transmission of Power. C. R. Tompkins (Am M–March.) 1000 w.

29900. The Pitch and Strength of Gear Teeth. Samuel Webber (M A–March.) 1200 w.

29901. Finding Squeaks and Knocks in Machinery. John H. Cooper (M A–March.) 1500 w.

29923.—$1.50. Platen Presses for Letter-Press Printing, Embossing, Cutting and Scoring. Ill. John Thomson (T C E–Dec.) 12800 w.

29937. Boiler Steel Requirements. From the Boiler Maker (I T R–March 7.) 1200 w.

29938. Lubricating and Bearing Cooling Devices in the Niagara Falls Power Plant. Ill. Frank C. Perkins (W E–March 9.) 500 w.

29941. Economy of Power House Operation. J. B. Craven (M S P–March 2.) 1800 w.

Serials

13033. Practical Hints to Boiler Makers and Templaters. Ill. (M W–Began May 12, 1893—16 parts to date—30 cts. each).

13534. The Gas Engine (M W–Began June 2, 1893—14 parts to date—30 cts. each).

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M–Began Dec. 7, 1893—Ended March 7, 1895—20 parts—15 cts. each).

21141. High Speed Steam Engines. John Radinger (E M–Began April, 1894—11 parts to date—30 cts. each).

24338. The Gas Engine. Ill. Anon. (P A–Began Aug. 15—9 parts to date—15 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (El–Began Aug. 31—14 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Ill. Theodore F. Scheffler, Jr. (M A–Began Oct.—6 parts to date—15 cts. each).

25611. Calculation of a Compressed Air Transmission When the Subsidiary Losses of Energy are Taken Into Account. From Professor Unwin's "Development and Transmission of Power" (E M–Began Oct.—4 parts to date—30 cts. each).

27574. The Stresses on Hemp Ropes and Leather Belts Used for Driving. M. Fauquier (P Eng–Began Nov. 30—Ended Feb. 8—4 parts—30 cts. each).

27594. Erection of a Corliss Engine. A. S. Mann (Pr–Began Dec.—4 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (M W–Began Dec. 7—4 parts to date—30 cts. each).

28021. Attachments and Conveniences for Milling Machines. Ill. Warren E. Willis (A M–Began Dec. 27—3 parts to date—15 cts. each).

28400. The Building of a Locomotive Boiler. W. D. Wansbrough (M W–Began Jan. 4—4 parts to date—30 cts, each).

28401. Boiler Trials. W. H. Wakeman (M W–Began Jan. 4—Ended Feb. 1—3 parts—30 cts. each).

28745. The Trials of Oil Engines at Cambridge. Ill. (P Eng–Began Jan. 18—5 parts to date—30 cts. each).

28926. Recollections of the Use of the Steam Indicator. F. F. Hemenway (M A–Began Feb.—2 parts to date—15 cts. each).

28967. On Results of Evaporative Tests in Land Boilers. George Carruthers Thomson (E–Began Jan. 25—Ended Feb. 15—3 parts—30 cts. each).

29417. The 48th Annual Meeting of the Institution of Mechanical Engineers (E–Began Feb. 8—Ended Feb. 15—2 parts—30 cts. each).

29484. The Determination of the Dryness of Steam. W. Cawthorne Unwin (I C T–Began Feb. 8—Ended Feb. 22—2 parts—30 cts. each).

29488. Some Reminiscences of Steam Locomotion on Common Roads. Ill. Frederick Bramwell (I Eng–Began Jan. 19—2 parts to date—45 cts. each).

29620. Underground Pumping Engines. H. Debauche (C G–Began Feb. 15—Ended Feb. 22—2 parts—30 cts. each).

29630. The New Nordenfelt Guns. Ill. (E–Began Feb. 15—2 parts to date—30 cts. each).

29777. The Deterioration of Locomotive and Marine Boilers Due to Expansion and the Means of Lessening the Same. Herr Lentz (A E R J–Began March—1 part to date—30 cts).

29886. Defects in Steam Boilers—From Report by the Austrian Association of Engineers and Architects (Ir Age–Began March 7—1 part to date—15 cts).

MINING & METALLURGY

A Great Drainage Tunnel.

AT Park City, Utah, is one of the greatest drainage tunnels connected with any mine. It is not quite so long as the Sutro tunnel and a few of the German tunnels, but is remarkable on account of the difficulties encountered, and also because the expense was met by but two mines, the Ontario and the Daly. The Salt Lake *Tribune* contains an interesting account of its history. The Ontario, after spending much money in pumping, about a dozen years ago ran its first drainage tunnel, about a mile long, tapping the 600-ft. level of shaft No. 3. As the mine became deeper, a very heavy Cornish pumping engine, with double 20-in. pumps, was put in to raise the water from the 1200-ft. level to this tunnel. Great steam pumps were added, and with difficulty and enormous expense the mine was unwatered down to the 1500-ft. level. But the costs were so great as to induce the managers to start another drainage tunnel in July, 1888, at a point 15,400 feet from where it was to tap No. 2 shaft, 1500 feet below the surface. For the first mile it is in porphyry, and thence to the 14,600-ft. mark in limestone with bunches of porphyry, the rest being in granite.

The difficulties from loose ground, cave-ins, and water were great. In November, 1889, a cave-in caused a delay of three months. Two side drifts, each 150 ft. long, were put in to drain the ground beyond, while repairing the caved portion. A year later a fire swept away the plant at the tunnel mouth, causing a loss of 60 days' time and $30,000. Just another year later a blast at the face let loose a flood, which drove every loose thing out of the tunnel, necessitating the raising of the tram track 18 in. and causing a delay of 71 days. In May, 1892, another flow was struck, causing a delay of 65 days,—a loss of 266 days by these four accidents. Other and numerous delays were caused by loose ground, which would run in as fast as it could be removed. In such cases piling had to be driven ahead, and in one instance it took 6 weeks to put in a 5-ft. set of timbers, when, after 2 weeks' preparation for the next set, the shoe on the other was found to be broken and the set had to be renewed—altogether 10 weeks of hard work required to gain 10 ft. At another place far back of the heading a small stream opened into a large crevice, causing a flow which shot out 100 ft. from the tunnel mouth, cutting through a bulkhead of 3-in. planks in a few hours.

A plant of compressors and blowers at the mouth supplied power and ventilation, the latter being always good, though the tunnel is one of the longest ever driven with only one heading and no intermediate shafts. The danger was not at the heading, but from swelling ground and crushed timbers behind. Constant watchfulness was demanded, and the pressure eased, crushed timbers being replaced by new 12 × 12 in. ones and steel bars, which did not always last long. Three 8-hour shifts worked continuously, except when accidents prevented.

The flow of water is now 10,000 to 15,000 gallons per minute, part of which is being used for power and light in the mills.

The total cost of the tunnel was about $425,000. It was completed October 10, 1894, the alignment being found to be very perfect. Inside of timbers it is 9 ft. high, 4½ ft. wide at top, and 5½ ft. at the bottom, with a water flume 5½ ft. wide and 21 in. deep. Total cutting is about 9 × 11 ft. The grade is ½ in. per rod.

Diamonds.

VERY many diamonds of small size have been found from time to time in the gold placers of California and at various localities in the southern Appalachians. The recent finding of two diamonds (of 2 and 1½ carats) in El Dorado county, California, has led the *Mining and Scientific Press* to publish an article on the occurrence and proper mode of prospecting for diamonds. "It may be," says the *Press*, "that some prospector will find a diamond mine,"—which is certainly very possible, in view of the frequent isolated discoveries in the United States.

Mr. Melville Atwood has classified the placers into three types,—surface washings, recent river beds, and ancient river beds. Such placers, yielding both gold and diamonds, occur in Brazil and California.

The outfit recommended by Mr. Atwood for diamond prospecting is elaborate, consisting of a light pick, a shovel, and two screws, one having ¾-in. apertures and 18-in. diameter, the other having eight holes to the linear inch, a large sack (a "miner's wallet"), a tub for washing the gravel in, a piece of rubber cloth for sorting the gravel, a watchmaker's lens, and a scale of hardness consisting of fragments of diamonds, sapphires, and quartz set in the end of a pencil in lapidaries' cement. The sample is put into the coarse riddle, and that fastened over the finer one. Both are immersed in a tub of water, the coarse gravel being caught on the top riddle, and mud and sand falling through the lower. Then the coarse is thrown away, and the top riddle unfastened; the lower is then jigged to get the heavier particles to the bottom and at one side, and this material is turned over quickly on the rubber to bring the heavy particles to the top. The stuff is then tested with the diamond scale pencil, and the particles examined with the lens. If no scratch is found upon one, it must be a diamond, no matter what the color or shape.

Mr. E. I. Dunn thinks that diamondiferous volcanic pipes, like those of South Africa, may yet be found in California.

A late discovery at Mt. Edgecombe, Alaska, shows that diamonds may occur in pumice and scoria.

Like the tedious and laborious prospecting operations described above, the actual treatment of diamondiferous earth on the large scale in South Africa is also very slow, but very sure. It is said that a half-carat diamond may be mixed with 200 lbs. of earth with the perfect assurance that it will not escape the various machines or the sorters.

It is established that the supposed diamonds found in meteorites near Cañon Diablo are actually such. Microscopic artificial diamonds have been made from other forms of carbon by means of the electric battery.

The total value of rough gems of all sorts produced in the United States in 1894 has been estimated at $237,000, of which diamonds formed too insignificant a part to be counted.

Acid or Basic Open-Hearth Plates.

FOR some time there has been sharp competition between the manufacturers of the two types of open-hearth steel, and it has been most intense in the case where the requirements are most rigid,—that is, in ship plates and boiler plates. As in the case of the old controversy between the different varieties of Bessemer steel, the basic process seems to have been gaining in favor, not simply because it can be produced at lower cost, but on its merits. The *Iron Trade Review*, which has devoted considerable attention to the question, lately said: "Both sides have had their victories, and the campaign is being pushed with vigor among ship-building companies." In a still more recent issue it remarks that "in one case specifications have been made that evidently leaned toward basic material, since 'open-hearth steel,' without qualification, was called for, and the question thus became merely one of price, with the result a foregone conclusion."

A writer in the *Maritime Review* (described as the head of one of the largest ship-building firms on the lakes), criticising an article in that journal, says: "The leading points sought to be made are (1) that the basic process is a new and untried one, recently resorted to for the purpose of obtaining at a reduced cost an open-hearth steel suitable for ship plates; (2) that basic open-hearth steel is inferior to the acid open-hearth, for the alleged reason that cheaper raw material is used in its production." The writer, admitting that it is true that the basic process is a comparatively new one in this country, argues that nevertheless it has been in successful use for a number of years at some mills in the production of boiler plates, etc., in which it had made for itself a recognized place long before its use for hull construction was contemplated, which has been only within the last year or so. He calls attention to the fact that in Europe, however, it has been in use for a long time, and for purposes requiring the highest qualities; that, after extensive investigations by the admiralties of the leading countries, it was adopted for the construction of war vessels; and that the United States government is using it freely in the construction of its new navy.

As to the metallurgical questions involved, the same writer says: "In the acid open-hearth process materials are selected which are sufficiently free from phosphorus and sulphur to produce the desired results in the finished material." He then claims that the acid process will not eliminate any of the phosphorus and sulphur impurities in the melting stock, and that, as the weight of the steel is reduced by oxidation of silicon, iron, etc., the percentage of the phosphorus and sulphur in the finished metal actually increases slightly. "The procedure of the basic manufacturer is precisely the same . . . [but], the basic process being essentially a refining one, these impurities are to a large extent removed." Finally he admits that there have been instances of failure of basic steel, but says that no one who knows anything about steel-making would pretend that the same thing has not happened with acid steel. The general conclusion seems to be that bad steel can be made by either process, but that, with careful selection of raw material and rigid specifications and tests, either will succeed.

Dredging for Tailings at Dayton.

It is well known that an enormous value exists in the tailings from the Comstock lode, Nevada, and is contained in the sands of the Carson river below the mills. The total production of the lode has been over $400,000,000 worth of ore, but of the assay value not over 75 per cent. has been recovered. At first very crude processes were in vogue, losing at least one-third of the assay contents; later the wet-crushing, pan-amalgamation mills guaranteed an extraction of 65 per cent., and finally of 72 per cent. Of the tailings in the river it is not known how much is recoverable, but the valuation is known to be so large that for very many years attempts were made by many persons and in various ways to recover some of the lost millions. The most persistent attempt has been by dredging, but hitherto with indifferent or no success.

The *Mining and Scientific Press* now announces that dredging is no longer an experiment, but from a financial point of view a decided success. The *Press* illustrates the fine plant of the Carson River Placer Mining and Dredging Co., a company which, after eight years of experiment costing $120,000, built last year a most elaborate plant for working on a large scale, having proved that great capacity was an absolute requisite. Most parts of the machinery are original in design, and the labor-saving devices are many and ingenious. The plant consists, first, of a powerful clam-shell dredger, capable of handling from 1500 to 4000 tons of the river material per day, the amount varying with the condition of the river and proportion of rock, gravel, and sand to be handled. Its engine is 150 h. p. Attached to the dredger is a barge carrying the screening machinery, agitators, quicksilver traps, sluices and riffles, etc. The power on the barge is furnished by two Pelton wheels of 80 and 30 h. p., driven by water conducted from a point several miles up stream. The shore plant is a three-deck mill, driven by outer impact wheels, containing a centrifugal pump, twenty-two concentrators, and a distributor. The fourth part of the plant is a mill for working the sulphuret concentrates. [The tailings contain free metals (gold, silver, and quicksilver) and gold- and silver-bearing sulphurets.]

The dredger delivers the material into a hopper, where cobbles and gravel are removed by grizzlies, the finer material passing into revolving screens in series down to 30-mesh. The pulp passing this mesh averages about 25 per cent. of the whole, and is sent by a centrifugal pump to the concentrating mill to another pump, which raises it to the distributor on the upper deck, whence it passes to the concentrators below. The system of sizing and concentration is very elaborate, since in the concentration and reduction mills the different classes of material require different treatment, the process being based on the continual elimination of barren sand and gravel under conditions favorable to recovering amalgam, free quicksilver, free gold, and sulphurets. The recovery really begins at the hopper, and continues by various devices, including riffles, traps, sumps, amalgamating plates, settling pans, and special treatment of sulphurets.

The Wall Rocks of California Gold Mines.

In the *Engineering and Mining Journal* Mr. W. H. Storms discusses the question of the influence of particular kinds of country rock or combinations of rocks on the richness and continuity of gold veins, and cites a very long list of examples in support of his views. After referring to the prejudice miners have for certain formations, he asks: "Are such prejudices well founded? Is it a fact that any particular kind of wall rock or combination of wall rocks may be considered an index of the value of a vein? Is a vein in a particular formation likely to prove more remunerative than in some other kind? Are ore shoots influenced in any manner by the wall rocks inclosing them?" The author admits that he may personally share with miners generally their prejudice for or against this formation or that, but thinks, "on the whole, that wall rocks are not a safe indication of either the richness or poverty of the vein or of its continuity." He does think, however, that "a careful examination of the wall rocks of a vein, as to whether they have undergone alteration from the normal rock or not, and to what extent this alteration has progressed, as well as an inquiry as to the causes which have brought about the change, will furnish a far safer basis for judgment than the mere fact that the walls are of this or that kind of rock." In this doctrine Mr. Storms will have the support of the most advanced opinion; that is, when applied to large areas containing scattered mines of any mineral. Yet probabilities are better than nothing, and they certainly can often be drawn for any given district that has been developed in part. It seems perfectly reasonable to look for similar results in a limited district where the same causes would be expected to have operated, while on the other hand (as is well known from experience) at distances entirely different sets of conditions may exist. In the case of gold mines the variations are very numerous.

Treatment of Gold Slimes.

While great progress has been made in the recovery of gold from battery tailings, scarcely any practical attempt has been made, says the London *Mining Journal*, to extract the metal from the slimes. This timely observation is backed up by the *Journal's* statement that nearly 600,000 ounces of gold were produced from tailings by the Transvaal mines alone last year; but it must be remembered that the peculiar treatment followed there does not aim at very close preliminary recovery, since in the Transvaal the working of tailings has been brought to a high stage of efficiency and economy, so that the first recovery is not so important as in other regions where the methods are different,—as, for example, in California and Colorado. Slimes are always made in wet-crushing, but the *Journal* estimates that in the Transvaal probably $1,500,000 is annually lost by the inability to treat them. "One radical proposal is simply to prevent the formation of slimes by increasing the fineness of crushing,"—which is rather a paradox. The *Journal* suggests dry crushing, by centrifugal and roller mills or by the substitution of pneumatic power for hydraulic in the ordinary stamp battery. This is just what has been done in many silver mills in Nevada, Idaho, and Montana, where roasting was necessary prior to amalgamation. But the *Journal* believes that the interference with existing plants that would result from a change to dry crushing is not likely to take place while the prospect of dealing separately with the slimes remains a hopeful one. It says that the claim is made that, so far as rich slimes are concerned,—that is, containing about 7 dwts. per ton,—successful treatment has already been achieved. The method is described as "disintegration and subsequent pressure." If the slimes are rich enough, they may be settled, bricked, and sent to a lead-smelter, if there is one near by; the question is as to low-grade slimes.

British and American Iron and Steel Trades.

COMPETITION in neutral markets for iron and steel between England and its continental rivals, Belgium, France, and Germany, has for some time been a theme of anxious study by English iron-makers. Now a new cause for alarm has been discovered in American competition. The *Coal and Iron Trades Review* (London), quoting a paper by Mr. Jeremiah Head, a high English authority who has visited the iron-making districts of the United States for the purpose of investigating costs of making and marketing iron and steel, says that the paper points in unmistakable terms to the coming supremacy of the United States in the manufacture of pig iron. "It is true that we have not yet been flooded with this cheap American (Alabama) iron in European markets, but it is not at all improbable that this event will happen by and by. The drawback to the success of the Alabama iron-makers at the present time is the comparative high cost of transport. Whether land and ocean transport will in the future be reduced sufficiently to enable a change to be made from this point of view is of course an unsolved problem, but the margin of 5*s.* now in favor of Alabama iron must be increased considerably before we need fear the advent of that product on British soil to any extent worth speaking of." The *Review* then goes on to say that certain other branches of the English iron and steel industries have been attacked successfully under conditions that may well cause a good deal of disquietude. Pittsburgh steel billets have been brought to about 6*s.* 6*d.* below Glasgow or Sheffield rates, and American wire manufacturers are leading in Central and South America and doing considerable business in Canada. The *Review* considers it "a curious economic problem" that this should have happened in a country where wages are understood to be 25 to 30 per cent. more than in England.

The Miner's Place in the World.

THE *Mining Industry*, of Denver, makes a strong plea for recognition of the miner. Among other things, it points out that the two productive industries which have made civilization possible are agriculture and mining, the former furnishing food and clothing, the latter the materials with which mechanical progress is made and the money which is the tool and servant of commerce and without which mankind would yet be swapping and as far behind the age as the fur-trading Indian is behind the banker and merchant. "The first occupation is a necessity of existence; without the second, civilization could not exist. Man emerged from a state of savageness only when he began to utilize metals, and his progress ever since has been measured by his advance in their use. We find the proof of this in the classification of the periods,—the stone, copper, bronze, iron, and, lastly, the gold and silver ages. The gradations of progress must have been first a hunter, secondly an agriculturist, and thirdly a miner. . . . Mining and metallurgy are the oldest of sciences. . . . Without the miner and metallurgist there could have been no iron and steel for tools, no coal for making them, nothing to set in motion the machinery, the arts, and the manufactures." The *Industry* claims that no racial exodus was ever begun for agricultural or climatic reasons, and cites the cases of antiquity,—of the Phœnicians going to Cornwall for tin then a precious metal; of Carthaginians and Romans ransacking Spain for gold and silver; of the Spaniards settling the new world in their search for gold. In later times: "California to-day would still be a drowsy Mexican province," had not Marshall one day found gold there. "Australasia would still have been the

Botany bay of banished convicts, if gold discoveries had not called to it a civilization unexcelled on earth." But it is needless to quote further; the imagination, once started, will fill in, imperfectly at least, the outlines of the picture.

Ontario's Effort to Make Pig Iron.

HITHERTO this important province has enjoyed the unenviable reputation of being without a single iron blast furnace, notwithstanding its large population, its local markets, and its rich resources in coal and iron ore. This is soon to be changed, however. *Iron Age* publishes a description of a large furnace plant, being built at Hamilton. It will have a 150-ton stack, 75 ft. high and 16 ft. wide at the boshes, provided with all modern appliances. The site, granted by the city of Hamilton, is said to be particularly advantageous as to cheap handling of material and product, being on a short branch of the Grand Trunk railroad and having ample dock facilities. It is stated that it will have an advantage of $5 per long ton over Nova Scotia competition. In freight there will be little advantage over American iron, but the duty and bounty combined ($6.72 per long ton) are almost equal to the cost of making iron in some parts of the United States.

Mica in Georgia.

A WRITER in *The Tradesman* (Feb. 15) states that mica is found in Georgia, associated with the veins of granite "which are in places interstratified with schists" containing gold bearing ores. The leads or belts have a northwesterly and southwesterly trend but only yield in pay districts at varying distances from each other. At present mining for mica is at a standstill in this region. The counties of Cherokee and White contain all the paying districts yet discovered in the state. The workings are said to be very shallow and neither the extent nor the permanency of the deposit are yet determined. The industry is retarded by lack of convenient railway transportation. A railroad into Lumpkin county is proposed, and, if constructed, will penetrate a mineral bearing district, containing not only mica, but gold, asbestos, soapstone, and corundum. These minerals are said to exist in Lumpkin county in quantities that may render mining profitable as soon as the requisite facilities for transportation are afforded, and provided also that the demand equals the supply. With carborundum as a commercial rival to corundum, and chemically prepared scrap-mica as a rival for mica, the prospect of such a demand may be doubtful.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Metallurgy.

*29152. Economic Possibilities of the Milling Machine. Horace L. Arnold (E Mag–April) 3000 w.

*29231. Tin-Plate in Wales and the United States. Editorial (Eng L–Feb. 1.) 1600 w.

29251. Melting and Refining Gold Bullion. Van F. Furman (Min R–Feb. 8.) 2500 w.

29274. Producer Gas as Applied to Foundry Purposes. George T. Prince (Ir Age-Feb. 14.) 3800 w.

29298. The Refining of Gold Sulphides. Werner Langguth—Read at the Virginia Beach Meeting of the Amer. Inst. of Min. Eng. (M S P–Feb. 9) 1600 w.

29344. Mescaba Ores in the Furnace (A M & I W–Feb. 15.) 1000 w.

*29350. New Processes of Gold and Silver Extraction. Anon. (A M S-Dec. 29.) 900 w.

29371. American Iron Products in Canada. (Extract) George E. Drummond (I T R–Feb. 14.) 1300 w.

29376. Northern versus Southern Iron—Some Points of Interest to Southern Iron Makers. C. A. Meissner (T–Feb. 15.) 2000 w.

*29431. The Principles of Lead and Copper Smelting (C T J–Feb. 9.) 600 w.

*29469. The Treatment of Gold Slimes. Editorial (M J–Feb. 9.) 700 w.

*29477. The Hematite Ore Trade and Its Revival. Walter J. May (C G–Feb. 8) 1500 w.

29500. Mesuré and Nouel's Optical Pyrometer. Ill. F. E. Thompson (Ir Age–Feb. 21.) 3500 w.

29501. Ontario's Effort to Make Pig Iron.—The Hamilton Furnace and Its Prospects. Anon. (Ir Age–Feb. 21.) 1500 w.

29547. British vs. American Iron and Steel. Editorial (E M J–Feb. 23) 1300 w.

We supply copies of these articles. See introductory.

29551. Lead Smelting in Scotland. A. H. Sexton (E M J–Feb. 23.) 1400 w.

29552. Proposed Eight Hour Day at English Furnaces. Anon. (E M J–Feb. 23.) 700 w.

29583. Acid or Basic Open-Hearth Plates. From the Marine Review (I T R–Feb. 21.) 1000 w.

29597. The Magnetic Properties of Nickel Steel. Edward P. Buffet (A M & I W–Feb. 22.) 1500 w.

*29614. The Solubility of Basic Slag. C. H. Ridsdale (C T J–Feb. 16.) 1000 w.

29683. The Uehling and Steinbart Pneumatic Pyrometer. Ill. (Ir Age–Feb. 28.) 1000 w.

29713. Abandoned Furnaces of the East. From the Philadelphia Record (I T R–Feb. 28.) 1000 w.

29714. Bench Molding. J. W. Dearsley (I T R–Feb. 28.) 1000 w.

29734. Barrel Chlorination of Gold. William M. Brewer (T–March 1.) 3300 w.

*29750. The Metallurgical Industries of Russia (B T J–Feb.) 900 w.

†29791. Separation of Nickel and Iron. E. D. Campbell and W. H. Andrews (A C J–March.) 700 w.

*29814. The Desulphurization of Liquid Pig Iron. Review of Article by A. de Vathaire (C G–Feb. 22.) 1100 w.

*29823. Plant for the Extraction of Gold by the Cyanide Process. (Abstract.) Charles Butters and Edgar Smart (Eng L–Feb. 22.) 800 w.

*29852. The Painting of Iron. A. Ashmun Kelly (I C B–Feb. 22.) 900 w.

29884. The Lake Superior Ore Situation (Ir Age–March 7.) 2000 w.

†29896. Science in the Foundry. Alexander E. Outerbridge, Jr. (J F I–March.) 1000 w.

Mining.

*29147. Gold Production in Colorado. W. C. Wynkoop (E Mag–April.) 1800 w.

*29162. Cast-Iron Tubbing. Arnold Lupton (I C T–Feb. 1.) 2400 w.

*29163. The Valuation of Mines. Editorial (M J–Feb. 2.) 1400 w.

*29191. Underground Haulage.—Tail and Endless Rope System and Tipples for Handling Large Outputs. T. B. De Armit.—Read before the W. P. C. M. I. (C E–Feb.) 4800 w.

*29192. The Protection of Miners. Andrew Roy.—Read before the Ohio I. of M. E (C E–Feb.) 1500 w.

*29193. Phosphate Deposits in Algeria. Report of Charles T. Grellet (C E–Feb.) 700 w.

*29194. The Greater Safety to Life and Property in Coal Mining Secured by the Employment of Certificated Mine Foremen. Editorial (C E–Feb.) 1800 w.

*29221. The Legal Meaning of "Mines and Minerals." Anon. (C G–Feb. 1.) 5000 w.

*29223. Sinking Shafts by Congelation at the Auzin Colliery. (Extract.) M. Petit (C G–Feb. 1.) 1500 w.

*29224. The Coal Mines of Servia. From Report of A. Leveson-Gower (C G–Feb. 1.) 2000 w.

*29241. Gypsum. Anon. (I C E–Feb. 1.) 1200 w.

29250. La Plata Gold Region. Ill. A. Lakes (Min R–Feb. 8.) 2000 w.

29319. The Coal Supplies of Polk County, Iowa. Floyd Davis (E M J–Feb. 16.) 1600 w.

29321. Lake-of-the-Woods, Ontario, Gold District. Walter Douglas (E M J–Feb. 16.) 1000 w.

*29352. Explosives for Mining Purposes. (Abstract.) J. House (A M S–Jan. 5.) 1900 w.

*29353. Geology of the Mount Drysdale District. (N. S. W.) J. B. Jaquet (A M S–Jan. 5.) 1300 w.

29373. Monazite. Its Uses, Its Nature and Its Location. Anon. (T–Feb. 15.) 2500 w.

29374. The Minerals of the Appalachian. W. M. Brewer (T–Feb. 15.) 1200 w.

29397. South African Gold and Diamonds. Interview with B. Coulson Bunn (Min R–Feb. 15.) 2800 w.

*29412. The Importance of the Gwelo District of Matabeleland. Editorial (Min W–Feb. 9.) 800 w.

*29413. The Management of the Mysore Mine. Editorial (Min W–Feb. 9.) 1300 w.

29465. The Miner's Place in the World. Editorial (M I T–Feb. 14.) 1000 w.

*29466. The Dundar Gold Fields. Brenton Symons (M J–Feb. 9.) 1200 w.

*29479. The Working of German Coal Mines (C G–Feb. 8.) 700 w.

*29480. The Coal Industry of France. From the Statisque de l'Industrie Minérale (C G–Feb. 8.) 4800 w.

†29486. The Dolgourouky Copper Mines. Anon. (I E–Jan. 19.) 900 w.

29524. Dredging at Dayton. Ill. A. C. Robbins (M S P–Feb. 16.) 1500 w.

29525. The Great East Lode of California. W. H. Storms (M S P–Feb. 16.) 1800 w.

29526. Diamonds. Anon. (M S P–Feb. 16.) 2300 w.

29548. The Wall Rocks of California Gold Mines. W. H. Storms (E M J–Feb. 23.) 3000 w.

29550. The Mining Exposition at Santiago, Chile. Anon. (E M J–Feb. 23.) 1600 w.

29553. Park County Gold Mines. Ill. Anon. (M I T–Feb. 21.) 1000 w.

*29599. Mining in Spain (Asturias) Anon. (M J–Feb. 16.) 1000 w.

*29601. The Concentration and Washing of Coal. Editorial (M J–Feb. 16.) 2000 w.

*29609. Electricity as Applied to Mining. G. S. Corlett (I & S–Feb. 16.) 5300 w.

*29621. Coal Mining in India. Extracts from Report of James Grundy (C R–Feb. 15.) 6600 w.

*29622. The Search for Coal over the Eastern Boundary Fault of the South Staffordshire Coalfield (Abstract). T. G. Meachem (C G–Feb. 15.) 2500 w.

29645. Ancient and Modern Tin Mining, Wilkins Trick (Min R–Feb. 22.) 1200 w.

29673. The Glendower Iron Deposit. W. G. Miller (C M R–Feb.) 2000 w.

29674. The Silver Mines of Thunder Bay. Peter McKellar (C M R–Feb.) 1300 w.

29675. Gold in Ontario and Its Associated Rocks and Minerals. A. P. Coleman (C M R–Feb.) 3500 w.

29677. A Few Notes on Merchantable Mica in the Laurentian. Ill. William Hamilton Merritt (C M R–Feb.) 1600 w.

*29739. Measurement of Water. Report of the Montana Society of Civil Engineers. A. M. Ryon (J A E S–Jan.) 3000 w.

*29751. Russian Coal Industry (B T J–Feb.) 1500 w.

29754. The Production of Precious Metals Since 1492 (E M J–March 2.) 700 w.

29755. The Australasian Gold Field of 1894. John Plummer (E M J–March 2.) 500 w.

*29800. More About the Gwelo District (Min W–Feb. 23.) 700 w.

*29831. The West Australian Gold Fields. Interview with the Well-Known Mining Expert, W. R. Fitzgerald Moore (M J–Feb. 23.) 3200 w.

*29833. Notes on the Espirito Santo Mines at Cana.—Its Drainage and Recovery. Ernest K. Woakes (M J–Feb 23.) 2000 w.

*29835. The Manganese Deposits of Huelva. Frank Johnson (M J–Feb. 23.) 1500 w.

*29836. The Recent Volume of Spanish Mining Statistics. Editorial (M J–Feb. 23.) 1800 w.

*29837. New Fields for Gold Mining. Editorial (M J–Feb. 23.) 700 w.

*29838. The Alabaster Industry. Extract from Report of Vice Consul Carmichael (A L–Feb. 22.) 3500 w.

29939. Pocket Mining in California. W. H. Storms (M S P–March 2.) 2000 w.

29942. Compressed Air as Used in Mines. (Abstract) Charles C. Hansen (E M J–March 9) 1200 w.

29944. The Goler Gold Diggings. Frank L. Nason (E M J–March 9.) 1000 w.

Serials.

20413. Mining Methods. Ill. (C E–Began March, 1894—12 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E–Began March, 1894—12 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E–Began March, 1894—12 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E–Began March, 1894—12 parts to date—30 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng–Began April 27, 1894—14 parts to date—30 cts. each).

22586. The Mineral Hydrocarbons (M S P–Began June 2—23 parts to date—15 cts. each).

22710. Science for Iron Mongers. By a Member of the Royal Inst. (Irm–Began June 2—16 parts to date—30 cts. each).

25689. A Typical Gold Mine Region—Description of Cripple Creek, Col. Ill. Arthur Lakes (C E–Began Oct.—Ended Feb.—5 parts—30 cts. each).

26386. Proper Foundry Construction and the Apparatus to be Used. Simpson Bolland (T–Began Nov. 1.—Ended March 1—7 parts—15 cts. each).

27329. Coal-Mining Economy Up to Date. Ill (I C T–Began Nov. 23—8 parts to date—30 cts. each).

27450. Cupola Tuyeres. Edward Kirk (Met W–Began Dec. 8—5 parts to date—15 cts. each).

28589. The Mineral Resources of Tasmania. A. Montgomery (A M S–Began Dec. 1—5 parts to date—30 cts. each).

28642. How Iron Is Made. Ill. John Birkinbine (F D–Began Jan.—2 parts to date—15 cts. each).

28736. The Mineral Wealth of Siberia (M J–Began Jan. 19—6 parts to date—30 cts. each).

28932. Cripple Creek Ore Deposits. Ill. Edward Skewes (E M J–Began Feb 2—2 parts to date—15 cts. each).

28975. Charbonnages Unis de L'ouest de Mons, Boussu, Belgium (C G–Began Jan. 25—Ended Feb. 1—2 parts—30 cts. each).

28978. The Iron Industry in the South of Russia. M. Paul Bayard (C G–Began Jan. 25—Ended Feb. 8—3 parts—30 cts. each).

28990. The Mining Industry as a Legitimate and Profitable Business. Milo H. Slater (M I T–Began Jan. 31—2 parts to date—15 cts. each)

29105. Diabese Dykes in the Sudbury Mining Region. T. L. Walker (C M R–Began Jan.—2 parts to date—15 cts. each).

29414. Hadfield's Steel Foundry. Ill. (E–Began Feb. 8—Ended Feb. 22—2 parts—30 cts. each).

29468. The Cyanide Process.—Its Practical Application and Economical Results. A. Scheidel (M J–Began Feb. 9—3 parts to date—30 cts. each).

29495. The Composition and Constitution of Certain Alloys. C. R. Alder Wright (Sc A S–Began Feb. 23—1 part to date—15 cts).

29753. The Sampling and Measurement of Ore Bodies in Mine Examinations Edmund B. Kirby (E M J–Began March 2—2 parts to date—15 cts. each).

29815. Geology of the South East Portion of the Congo Basin and the Metalliferous Deposits of Katanza. Anon. (C G–Began Feb. 22—1 part to date—30 cts).

29817. Recent Developments in Coal Mining in Japan. Ill. Anon. (Eng L–Began Feb. 22—1 part to date—30 cts).

MUNICIPAL ENGINEERING

Sanitary Engineering.

The Journal of The Franklin Institute for March prints a lecture delivered by Mr. Paul Gerhardt at the Franklin Institute (Feb. 15). The lecture presents an exhaustive view of this branch of engineering, which has been differentiated as a specialty in obedience to the modern tendency toward specialization in all the industrial arts and allied professions. The promotion of conditions which tend to decrease the death-rate and increase the health-rate of communities is the purpose of all works of sanitary engineering, as defined by Mr. Gerhardt, and "a general knowledge of architecture and of civil engineering should form the basis of the education of the sanitary engineer." Following this, there should be a general preparatory course in natural sciences and mathematics, in the principles of construction, in the stability of structures, in draughtsmanship, and in manual training, without all of which no engineer can attain eminence; and the student should learn the rudiments of engineering as relating to commerce, to agriculture, manufacturing industries, mining, building, and public health. The sanitary engineer should also study sanitary science and everything pertaining to public and individual health, including first aid to the injured in accidents or emergencies, so common in the actual practice of the engineer.

The water-supply of cities may have deficiencies in quality, quantity, or pressure; sewerage systems may be defective, and even the streets and pavements of a city may possess elements which are detrimental to health. It is the office of the sanitary engineer to discover and prescribe remedies for all such deficiencies. In the laying-out of new cities, as well as in improving the sanitary conditions of older municipalities, his counsel will be needed in preventing the adoption of unsanitary plans, and in the arrangement of streets, parks, and open squares in such manner as to promote both convenience for traffic and a high standard of health. The necessity of having plenty of public squares, parks, open spaces, and airing grounds in cities is explained, as well as the desirability of having rows of trees planted in the wider streets, all of which tend to increase the salubrity of a city by lessening street dust, removing street noises, maintaining a purer atmosphere, and affording playgrounds for children and opportunities for recreation to the working-people and the city poor. Water-fronts of harbor towns, or cities situated on the banks of rivers, should be beautified and improved, and not form, as usual in American cities, their least attractive portion. All natural water-courses traversing a city should be kept unpolluted, and none should ever be used as sewer outlets. The need of well framed building and sanitary regulations for all cities is pointed out, and the services which sanitary engineers can render in the enforcement of city ordinances is explained. The sanitary works mentioned form together a sanitary system of wide scope, which provides safeguards for the public health and secures general town sanitation. Other sanitary problems, like smoke prevention, city cemeteries, cremation, drainage of swamps, prevention of inundations and storm-flood, and the sanitary influences of forests, are discussed. The sanitation of the dwelling, the protection of buildings against the elements, the problem of housing the poor in large cities, the planning of hospitals, prisons, and military barracks, the necessity of establishing people's baths in populous city districts, the requirements of safety from danger of fire or panic in theatres and halls of audience, and other problems are not the least interesting part of the lecture. Industrial hygiene, including the prevention of machinery accidents, abatement of nuisances, regulation of offensive trades, and sanitation of summer resorts, railway cars, ferry-boats, and sea-going vessels, are all touched upon.

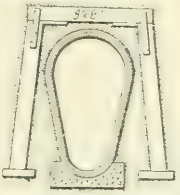
The lecture concludes with a brief allusion to the trades allied to sanitary engineering, and recommends that, "inasmuch as sanitary engineers are by the nature of their special training specially qualified and well-fitted to be identified with public matters, their profession should in the future be freely represented in boards of public works, of health, of education, of charities, as well as in city councils, city improvement societies, and citizens' committees."

Tunnelling through Quicksand.

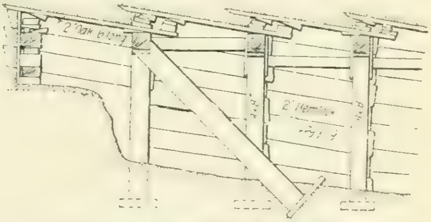
A LETTER addressed to *Engineering News* (Feb. 21) by Mr. Willard D. Lockwood, Jun. Am. Soc. C. E., is of general interest to engineers. As it is not long, we copy it entire.

"In the course of construction of the Goodman St. and State Hospital sewer at Rochester, N. Y., the contractors were obliged to drive a tunnel through a hill of quicksand about 500 ft. in length. As most of the work around Rochester has been in rock, the contractors were apparently afraid of the work. The contractor to whom the work was finally awarded went at it as well as he knew how, but at the end of a second month he found that his men had advanced only 100 ft., and that the men were becoming more afraid of the work every day, as bad cave-ins were very frequent, at times completely burying the men in the breast. The contractor thus found himself paying out double the money he would receive from the city, and was very glad to give a sub contract to Mr. William Jones of Pittsburg (a man of long experience in soft-ground work) and the author.

"After we had looked the ground over, we decided to erect a simple builder's derrick over the shaft and use cars and flat skips. As the amount of material that would be removed from the breast in each shift was very small, the heading being 6 × 6 ft., we decided to work the derrick by hand, the muckers raising their own cars. We placed in charge of the work Mr. John Collins of Philadelphia, a soft-ground miner of unusually varied experience. As soon as Mr. Collins had got together miners for two shifts, he examined the breast, and found it in such bad condition that it took nearly a week to get in the first set of timbers. The ground being finally caught up, the miners felt more at ease and began their excavating, thinking that their trouble was over; but the next day, without the least warning, the breast came in with a rush, and, had it not been for the unusual care taken by Mr. Collins in placing his timbers in the breast, the men would all have lost their lives. After this inflow was removed, all went well for the next 100 ft., when a bed of boulders was encountered embedded in the quicksand, and, as it was impossible to think of blasting with ever so light charges in such material, it was only by the slowest progress and utmost watchfulness on the part of the men that the danger was passed. At times the quicksand was almost as hard as rock in the breast, but at the same time it would come in instantly if given the least chance.



Cross Section of Finished Tunnel.



Longitudinal Section, Showing Method of Timbering

Constructing a Sewer Tunnel in Quicksand, Rochester, N. Y.

"The timbering in the breast was done with a center leg, and in some cases a false cap and raker, the completed work being tied up with stretchers. The timbers were placed about 4½ ft. c to c., using 8 × 8 in. hemlock, with 6-ft. oak lagging 2 in. thick on top and 2-in. hemlock lagging for the sides. The lighting of the tunnel was done entirely by candles, with a gasoline torch at the top of the shaft for the night shift.

"Even with the unusual precaution taken and the corresponding extra time taken in the start of each shift, the work was advanced on the average of 4½ ft. to a shift. The work was done with two miners in the breast and two muckers loading their own cars and raising them by hand to the dump. The shaft, being in a low place, was but 25 ft. deep. The men usually completed their day's work—that is, as a rule, one set of timbers—in seven to eight hours. The miners were paid $2.50 per day, and muckers $2. The work of driving and timbering the tunnel complete amounted to $5 per lin. ft.,—that is, $2 per ft. for timber, lights, and tools, and $3 per ft. for labor."

Tests of Cement Joints for Pipe Sewers.

THE JOURNAL OF ENGINEERING SOCIETIES for December was delayed (as we are informed by Secretary John C. Trautwine) by the preparation of the annual summary of the "Monthly Index to Current Engineering Literature," which comprises ninety pages. It reached us too late to be available for review in our March number. It contains a paper by Freeman C. Coffin, member of the Boston Society of Civil Engineers, which, under the above title, deals with a practical subject of importance to municipal engineers. The author ates the undesirability of the infiltration of ground water into sewer pipes w he the effluent is to be treated by infiltration after its discharge, on account of the increase of the volume of discharge to be treated. He also considers the infiltration of ground water undesirable in that it upsets the calculations by which engineers are guided in designing sewers, since "in a self-cleansing sewer it is nearly as important to have the sewer small enough as to have it of sufficient capacity. It is well known that there is more or less leakage of ground water in all systems of pipe sewers, and in some cases it is a large percentage of the system. Undoubtedly this leakage is largely caused by the fact that it is difficult, if not impossible, to make joints in a wet trench. By a perfect joint I mean one that is completely filled all around with cement. This difficulty is greatly increased by the shortness of the length of pipe; and the narrowness of the joint room in the so-called standard form of joint adds to the difficulty of filling it with the cement mortar, especially when, as is often the case, the pipes are not concentric. It is customary to overfill these joints, making an angle of about 45° between the outside face of the cement and the side of the pipe. This assists in preventing the inflow of water, but, when the pipes are laid in a trench in which water is present, it is nearly impossible to keep the mortar intact until it is set. The shortness of the pipe—not exceeding 3 ft.—makes it very hard to dig a bell hole large enough

FIGS. 1 AND 2

FLUSH JOINTS.

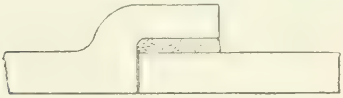


FIG. 1

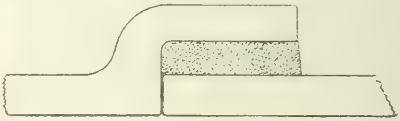


FIG. 2

FIGS. 1 AND 3. STANDARD SOCKETS.

FIGS. 2 AND 4 DEEP SOCKETS.

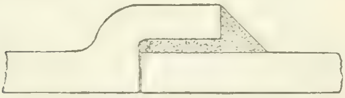


FIG. 3.

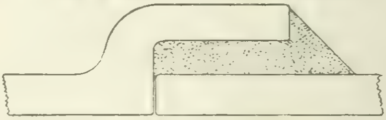


FIG. 4

FIGS. 3 AND 4

OVERFILLED JOINTS.

to work in and to provide for the suction of a pump, while still keeping the pipe in proper alignment; and the water cannot so well be dammed back while the joint is being made, as in a longer one, such as a water pipe. The Portland Stone Ware Co. has recently begun the manufacture of sewer pipes with wider and deeper sockets, under the name of 'deep-socket' pipe. The shape of this socket is shown by Figs. 2 and 4, and the standard socket is shown by Figs. 1 and 3. All four figures represent joints for 6-in. pipe. It is hoped that the use of these joints will facilitate the extension of better work. The city of Brockton has used the pipe in its new sewerage system. The following table gives dimensions of these joints from 4 to 24 in. diameter."

TABLE OF DEEP-SOCKET PIPE.

Size.	Depth of socket.	Thickness of joint room.
4	2 5-8 inch	5-8 inch
6	2 5-8 "	5-8 "
8	2 5-8 "	5-8 "
10	2 5-8 "	5-8 "
12	2 5-8 "	5-8 "
15	3 1-8 "	5-8 "
18	3 1-8 "	5-8 "
20	3 1-8 "	5-8 "
24	4 "	5-8 "

"While preparing for these tests, I had some apprehension that there might be no leakage in a perfectly-made joint under so light a pressure" (5 ft. head). "To have the tests of any value, it was necessary to make the joints in as uniform a manner as possible, and therefore as well as could be done, which it was comparatively easy to do with the pipe in a vertical position during the process. Under such conditions it seemed possible, if not probable, that there might be no measurable leakage, and therefore no means of comparing the different kinds of joints; but a consecutive record of the tests shows that, out of the sixty-three tests, only three failed to show leakage, and in these the leakage was not prevented by the use of cement alone."

The tests were carried out with Rosendale and Portland cements and different mixtures and appear to have been very exhaustive. A full description of the apparatus and methods of testing is given, with an illustration of the apparatus, and a table of results. The latter are decidedly favorable to the deep-socket pipe. Painting over the joints with asphalt varnish reduced the leakage very much. Mr. Coffin believes that leakage of deep-socket pipe joints may be reduced to 150 gallons per mile of 6-in. pipe per day of 24 hours, with proper care in laying it, and when neat Portland cement is used for making the joints, the pipe lengths being 2 ft.; but he recommends a trial of 3-ft. pipe lengths.

Water Gas From Bituminous Coal.

IN a paper read at the annual meeting of the American Gas Light Association, and published in full in the *Gas Light Journal*, Mr. F. Egner presented a very thorough *résumé* of recent progress in making water gas. This product, as is well known, is formed by bringing carbonaceous material to an incandescent condition, and then passing steam through the mass, thereby decomposing both; afterwards the gas thus produced is either carburreted or not, with crude petroleum or some other liquid or volatile liquid hydrocarbon. The carbonaceous material is either anthracite coal or culm, bituminous coal or slack, or gas retort house coke. "In the early days of water gas," says Mr. Egner, "one of the objections urged against it was that bituminous coal could not be employed in its manufacture. Even retort house coke was pronounced by supposed good authorities to be altogether unsuitable for the purpose. . . , But it has been done; and now we know that good retort house coke, weight for weight, is better than anthracite for the purpose, and it is only a matter of cost which should be used." The author takes up the history of the attempts to use bituminous coal, describing early experimental plants, and gives a detailed account of a later successful plant at Chicago, operating on this system, having a capacity of 400,000 feet daily of fuel and illuminating gas, and using a bituminous coal which is not a gas coal. Details of construction of plant, methods pursued, cost, and comparisons are given in profusion, with illustrations of generators. The figures quoted and the tone of the essay indicate a belief that there is a promising future for water gas made from bituminous coal.

MR. N. N. DAVIS says in *Fire and Water*, that the prime factor of any basis rate is fire protection. Water works constitute the most preferred fire protection, hence, control "basis rates," as is evidenced by the fact that towns and cities are classified as follows: First class cities or towns have a fully paid fire department, electric fire alarms adequate water works. Second class have volunteer, or partly paid fire department, and adequate water works. Third class have volunteer fire department, with steamers, but inadequate water supply (from cisterns or steamers), or hand engines and adequate watersupply from cisterns, etc., not water works. Fourth class have no adequate water supply nor fire department. This classification shows the chief conditions under which a risk is to be assumed in any town and indicate the economy of a well-equipped fire department.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Gas Supply

*29181. The Efficiency of Luminous Combustion. Harold B. Dixon (J G L–Jan. 29.) 3000 w.

*29182. A Plea for Gas Stokers. By a Country Manager (J G L–Jan. 29) 2500 w.

*29183. Incandescent Lighting by Water Gas. (Abstract.) H. Strache (J G L–Jan. 29.) 900 w.

*29245. Interview with Dr. Dvorkovitz (G W–Feb. 2.) 3800 w.

29330. Municipal Ownership of Gas Works. Editorial (P A–Feb. 15.) 1300 w.

29331. Notes on Modern Gas-Making Plant. Working Up of Gas Liquor. Ill. G. Schimming (P A–Feb. 15.) 3500 w.

29343. Fuel Gas of the Future. J. A. Faux (A M & I W–Feb. 15.) 1800 w.

*29346. Acetyline and the Gas Industry. Norton H. Humphreys (J G L–Feb. 5.) 1400 w.

29378. Argument by the Hon. Henry C. Kelsey before the House Committee on Municipal Corporations of the New Jersey Legislature in Opposition to the Proposed Dollar Gas Rate for Certain Cities of that State (A G L J–Feb. 18.) 5500 w.

*29423. Testing of Incandescent Gas Burners. Tests of Professor Wedding (G W–Feb. 9.) 400 w.

*29424. The Efficiency of Carbon Vapor in Coal Gas and Other Hydrocarbon Flames, and Other Matters of Interest in the Manufacture of Coal Gas. (Extract.) Lewis T. Wright, with Discussion (G W–Feb. 9.) 4500 w.

*29460. Gas Testing in Street Culverts. Ill. Frank Clowes (El–Feb. 8.) 1800 w.

*29523. The Trial of Oil-Gas Plant at the Bradford Gas Works.—Report on the Experiments with Dr. Dvorkovitz's Process (J G L–Feb. 12.) 1700 w.

*29567. From the Electric Furnace.—A Product of Interest to Gas Manufacturers. Anon. (E R L–Feb. 15.) 1800 w.

*29602. The Incandescent Gas Light for Use in the Optical Lantern. John A. Hodges (G E M–Feb. 11.) 1200 w.

*29603. The Determination of Tar in Gas. W. Leybold (G E M–Feb.) 1100 w.

29635. The Effect of the Introduction of the Welsbach Lamp on the Business of the Gas Company. Joseph E. Nute, with Discussion (A G L J–Feb. 25.) 1000 w.

29720. The Guide Framing of Gasholders. F. S. Cripps (P A–March 1.) 2000 w.

29722. The Proper Location of Gas Meters in Buildings. Samuel Abbott, Jr. (P A–March 1.) 800 w.

29724. Whose Make of Lighting Fixtures Shall We Recommend? W. M. Eaton (P A–March 1.) 1100 w.

29725. The Heating Effect of Artificial Lights. Henry W. Douglas (P A–March 1.) 800 w.

29762. Some Card Catalogues in Use for Record of the Outside Work of a Gas Company. S. J. Fowler, with Discussion (A G L J–March 4.) 4200 w.

*29767. The Detection of Poisonous Water Gas in the Air, and of Explosive Gas in Electric Culverts. Ill. Frank Clowes (J G L–Feb. 19.) 1500 w.

29778. Operation of Water Works with Gas Engines. Comments on Article by Max Muenzel (A M & I W–March 1.) 400 w.

29779. Proportional Scale for Mixture of Natural Gas with Rose-Hastings Manufactured Gas (A M & I W–March 1.) 600 w.

*29825. The Recovery of Bye-Products from Producer Gas. A. Gillespie (I & I–Feb. 22.) 2800 w.

*29863. On the Relative Values of Benzol and Carburine for Gas Enrichment. Lewis T. Wright (G W-Feb. 23.) 1800 w.

*29879. Inaugural Address of S. W. Durkin (J G L–Feb. 26.) 3500 w.

*29880. C. R. Bellamy on the Consumption of Gas for Lighting (J G L–Feb. 26.) 4000 w.

29545. Building a Sewer Tunnel in Quicksand. Ill. Willard D. Lockwood (E N–Feb. 21.) 500 w.

29699. The Sewerage System of Los Angeles, Cal. Ill. Burr Bassell (E N–Feb. 28.) 4800 w.

Streets and Pavements.

29252. Annual Report of the Massachusetts Highway Commission (G R–Feb.) 4800 w.

29379. Hard Material Sidewalks. Anon. (Municipality and County–Feb.) 1500 w.

†29489. Pyingado for Wood Pavement. J. Nisbet (I Eng–Jan. 16.) 1200 w.

29572. Recent Work of the Massachussetts Highway Commission. Ill. (E R–Feb. 23.) 3500 w.

*29792. Views of Practical Men on Paving Brick. Daniel W. Mead, with Discussion (P–March.) 4800 w.

*29793. The Testing of Clay Paving Material. Edward Orton, Jr., with Discussion (P–March.) 8000 w.

*29794. "Can Shale Paving Be Toughened by an Annealing Process in Burning?" William S. Williams (P–March.) 1500 w.

*29795. Elements of a Good Paving Brick.—Discussion (P–March.) 3500 w.

Water Supply.

29185. The Interpretation of Water Analysis. J. C. Thresh (A A–Feb. 9.) 1200 w.

29248. The Peterborough Water Works. Ill. A. C. McCallum (C Eng–Feb.) 2500 w.

29570. New Gravity Water Works, Portland, Ore. (E R–Feb. 23.) 1300 w.

29646. Metropolitan Water Supply.—Boston and Adjoining Places to Have a New System (F W–Feb. 23.) 1300 w.

29695. Specifications for Stand-Pipes. William D. Pence (E N–Feb. 28.) 11000 w.

29731. Economy of Water Works. N. N. Davis (F W–March 2.) 1000 w.

*29736. The St. Louis Water Works. Ill. I. Historical. M. L. Holman. II. Points of Interest in the Design and Construction. S. Bent Russell. III. New Machinery. John A. Laird. IV. Quality of the Supply. Robert E. McMath. V. The Filtration of City Water Supplies in the Light of Recent Researches. Robert Moore (J A E S–Jan.) 24000 w.

*29737. Tests of Non-Conducting Pipe Coverings. Ill. John A. Laird (J A E S–Jan.) 600 w.

29780. The Proposed Boston Metropolitan Water Supply (E R–March 2.) 7700 w.

29930. The Proposed Boston Metropolitan Water Supply (E N–March 7.) 4200 w.

†29948. The London Water Supply. Major Greenwood (San–March.) 2200 w.

Miscellany.

*29146. Municipal Ownership of Public Corporations. M. J. Francisco (E Mag–April.) 3500 w.

*29151. The Control of Public Service Corporations. Allen Ripley Foote (E Mag–April.) 2500 w.

29332. Sanitation. Robert Morgan (Met W–Feb. 16.) 1500 w.

29359. The Parks and Proposed Parks of Washington City. Anon. (A A–Feb. 16.) 2300 w.

29437. Defacement of Parks in Buffalo. Editorial (G & F–Feb. 20.) 1200 w.

*29522. Aeration as a Means of Purifying Sewage and Water. J. H. Curtis (E N–Feb. 21.) 2000 w.

29573. Recent Observations on Electrolysis, Brooklyn, N. Y.—From Report of John A. Barrett (E R–Feb. 23.) 2000 w.

*29643. London and Foreign Fire Brigades. Editorial (Eng L–Feb. 15.) 2000 w.

29670. The Care of Urban Parks. (Extract.) William McMillan (G & F. Feb. 27.) 1300 w.

†29685. Blackmail as a Heritage; or New York's Legacy From Colonial Days. Clarence Clough Buel (C M–March.) 10000 w.

†29686. I. Civic Self-Knowledge. II. The Cure for Municipal Corruption (C M–March.) 2400 w.

29697. The Granting of Franchises by Towns and Cities. Editorial (E N–Feb 28) 1600 w.

*29768. Water Supply and Sewage Disposal in Some Large European Cities. (Abstract.) J. S. Billings (J G L–Feb. 19.) 4200 w.

29891. City Engineers and Public Parks. Editorial (G & F–March 6.) 1400 w.

*29917. The Work of Village Improvement Societies. B. G. Northrop (F–March.) 4500 w.

†29949. The Collection and Disposal of Refuse and Garbage of Large Cities. (Extract.) W. F. Morse (San–March.) 4500 w.

Serials.

5358. Sewage Purification in America. Ill. (E N–Began July 14, 1892—44 parts to date—15 cts. each).

24751. The Gas Manager Abroad (G W–Began Aug. 25—12 parts to date—30 cts. each).

27636. The Economic Principles of the Gas Producer. Anon. (M W–Began Dec. 7—Ended Feb. 15—5 parts—30 cts. each).

28265. Frontinus on the Water Supply of Rome, A. D. 97. Clemens Herschel (E R–Began Jan 5—2 parts to date—15 cts. each).

28762. Filtration and Purification of Water. Ad. Kemna (I C B–Began Jan. 18—3 parts to date—30 cts. each).

28854. Water Purification. Rudolph Hering (J F I–Began Feb.—Ended March—2 parts—45 cts. each).

29316. Steel and Cast Iron Conduits. I. M. de Varona (F W–Began Feb. 16—1 part to date—15 cts).

29647. Water and Water Works. John W. Hill (F W–Began Feb. 23—2 parts to date——15 cts. each).

RAILROADING

Timber-Preserving Methods and Appliances.

A PAPER of more than usual interest upon this subject was read by Mr. W. G. Curtis, assistant to the general manager of the Southern Pacific Company (Pacific System), before the Technical Society of the Pacific Coast, December 7. *The Railroad Gazette* (Feb. 8) has published this paper in full, and those who desire the broadest information obtainable upon the subject are advised to read it. Only meager samples of its quality are possible here. Numerous illustrations help to elucidate the text. The author disclaims any intention to treat the subject exhaustively, confining himself strictly to a description of the process and portable plant used by the Southern Pacific Company, which, from the description, appears to be complete and convenient.

The experience of the Southern Pacific Company with zinc chloride for treating pine and fir ties has demonstrated that the process is economical. "One wood-preserving plant, having a capacity for treating about 2,500 ties per 24 hours, is amply large to burnettize all of the ties required for the Southern Pacific lines naturally supplied with ties from the pine and fir forests. The conditions are such, however, that to locate the plant at some station in the ordinary way would involve a very great cost for hauling the ties from delivery points to the wood-preserving works, and thence to point of use. The cost of four fixed plants, which would be required to reduce the cost of transportation to reasonable limits, was also out of the question. These difficulties led to the design of a portable plant, which was put into operation in June, 1894."

An illustrated description of this plant is given. "The plant comprises all of the appliances essential for creosoting, burnettizing, and all of the ordinary wood-preserving processes; one car carrying two steam boilers, steam winch, tools, wire rope, etc.; one car carrying superheater, measuring tank, force pump, air and circulating pump and condenser; two cars, each carrying three wooden supply tanks for holding the preservative fluid, each tank having a capacity of 24,000 gallons, and two retorts, each 6 ft. diameter by 114 ft. long, divided into sections, each section carried on two heavy car trucks. This plant, made up into a train of eight cars, made its initial journey from Sacramento, Cal., to Cornelius, Ore., 706 miles, last May, passing over 3.3 per cent. grades, and around the 14-degree curves of the Siskiyou mountains, without difficulty."

The arrangement of tracks, setting up of the plant, process of charging and handling ties, burnettizing treatment for railway ties, and the preparation of the fluid, are each separately treated. The process, as described by Mr. Curtis, comprises six steps. (1) "The charge is run in, and the heads or doors [of the retort] are closed up." (2) A preliminary vacuum is begun; this is to run up to about 20 in. During the vacuum the doors are bolted tightly. This vacuum process requires about 10 minutes. (3) Live steam is let in at about 30 lbs. pressure, and continued for about 4½ hours; it is then blown off, requiring half an hour. During this steaming and blowing off the retorts are drained. (4) A second vacuum is created, of from 22 to 26 in., which is maintained for about an hour, (5) The retort is filled with the zinc chloride solution, and pressure begun. This is continued until the required quantity of solution is injected into the ties. (6) The surplus preservative fluid is drawn off, the doors opened, and the charge pulled out on the platform. Another charge, which has in the meantime been made ready, is immediately pulled into the same retort to undergo the same process. The treated ties are unloaded onto adjoining cars, and the trucks are pushed to a small transfer table at the end of the platform, transferred to the opposite track of the same platform, and loaded with fresh ties to be run into the other retort for treatment. Trucks sufficient for three charges of ties are used.

The time of treatment varies with the kind of timber treated and the length of time the ties have been allowed to season. In steaming, a pressure of about 20 lbs. per sq. in., corresponding to a temperature of about 260° F., is employed. The stock zinc chlorid solution contains 43 per cent. of zinc chlorid, 2 per cent. of impurities, and 35 per cent. of water. In use 27 lbs. of the stock solution per 100 gallons of water is the proportion employed.

The paper concludes with a description of the modes of testing the ties, and the records of charges, dates, durations, pressures, and temperatures for each charge, the latter being numbered for reference. In testing, borings taken from sample ties are separately "turned to an ash over a gasoline jet in a porcelain roasting-dish in contact with the air. The ashes are carefully collected in a platinum cup, and distilled water added, with a slight excess of hydrochloric acid, converting the zinc oxid into zinc chlorid. It is then filtered into a test tube, and the zinc hydrate thrown down with sodium carbonate, making a white floculent precipitate. The liquid is then made up with distilled water to 3 drachms. The resulting milky fluid is compared with standard liquids in tubes of the same size as the test tubes, each tube containing 3 drachms." This railway has found it economical to manufacture for itself the zinc chlorid used for burnettizing.

Balanced Locomotives.

IN an article by Mr. Geo. S. Morison (*The Railroad Gazette*, Feb. 22) the balancing of locomotives is treated in a plain, common-sense, and convincing argument, in which the inadequacy of all pre-existing systems of locomotive balancing is clearly shown, and the final conclusion is reached that only in the four-cylinder compound locomotive has there been obtained a perfect balance at all speeds.

After briefly alluding to the attention recently paid to this subject, and a number of interesting discussions and papers which it has called out, the writer states the general problem to be solved in locomotive balancing. "Any mass of matter in motion tends to move at a uniform speed, except so far as retarded by external friction. The uniform rate of speed, however, is not that of any one portion of the moving mass, but of the center of gravity of the whole moving mass; if, therefore, the center of gravity changes as the mass moves, the motion of no one portion of the mass will be uniform, but will change as the center of gravity changes. In a locomotive every time a moving part changes its place, the center of gravity moves also, and the speed at which each part of the locomotive moves varies. As the connection with the train is not made with the center of gravity, but with the frame of the engine, the engine does not pull the train at a uniform speed, but with a speed that varies with every motion of the moving parts of the engine. In order to overcome this difficulty, counterbalancing is used, the counterbalancing being added in the form of weights in the driving wheels opposite to the cranks, so that, when the cranks move forward, the weights will move backward, etc.; by this method all revolving parts can be balanced with practical perfection, and the center of gravity kept constant. The moving parts, however, are not all revolving parts; the piston rods, cross-heads, and the forward half of the main rods have a reciprocal motion back and forth, and not a rotary motion; in other words, they disturb the center of gravity in a horizontal plane, but cause no vertical disturbance. If these reciprocating parts are balanced by revolving counterbalances, those revolving counterbalances can overcome the horizontal movement of the center of gravity, but will create a vertical disturbance of this center of gravity precisely equal to the horizontal movement which they balance. As, however, the horizontal movement is the one which creates an irregular pull on the draw-bar and gives a jerky motion to the engine and train, this horizontal disturbance is balanced, though at the expense of a vertical disturbance."

Within a few years a study of the wear of rails has shown that all the old methods of balancing were defective, and that they permitted vertical disturbance, the effects of which were clearly indicated on the rails, and which were also indicated in other ways. "Reduction of the weight of reciprocating parts . . . . is admittedly a reduction, and not a cure. . . . The balanced compound locomotive meets this requirement by the use of four cylinders,—two high-pressure and two low-pressure; the high-pressure cylinders are placed outside the frames, and connect on crank pins. The crank pin on each side is placed directly opposite the axle crank on the same side, so that, while the high-pressure piston is moving forward, the low-pressure piston is moving backward, and the reciprocating parts of one balance the reciprocating parts of the other. On the other side of the engine the same arrangement exists, the cranks on one side being set on the quarter from those on the other, so that the four cranks are at right angles to each other." It is further shown that the use of large driving wheels is unnecessary with such locomotives, but that the system admits the use of "the small wheels which are needed to make quick starts, and yet can be run with perfect safety at extreme speeds between stations."

Boiler Covering.

THE subject of boiler covering as specially related to locomotive boilers is treated in a paper read at a recent meeting of the Northwest Railroad Club, and printed in the *Railway Age* (Feb. 15). The loss of heat from uncovered locomotive boilers is not determined, but from their exposure to winds and storms it is assumed to be far in excess of loss from an uncovered stationary boiler. The average loss from the latter has been determined to be 15 per cent.

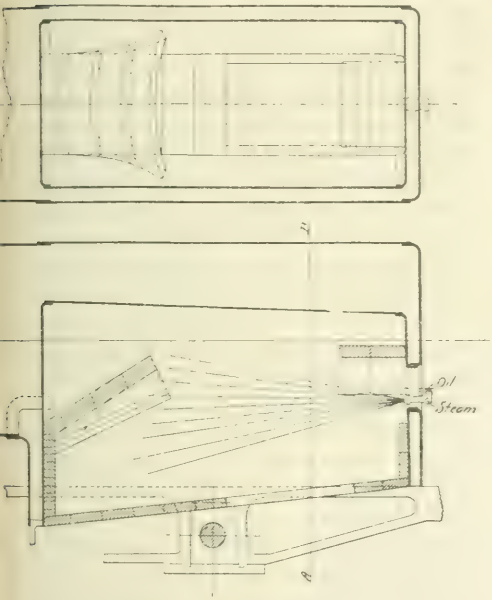
In this country locomotive boilers are almost universally covered with "pine wood, sheathed with a jacket of Russia, planished, or common iron. Ten per cent. will cover the number of locomotive engine boilers in the United States that are covered with other material than wood. The ordinary method of applying wood covering is to secure it to flexible hoops encircling the boiler, leaving an air space between the boiler and the covering. It is generally admitted that, in order to obtain the best results, an air space between the boiler and the covering is necessary; but, in order to be effective, it should be practically air-tight, to prevent the circulation of air between the covering and the boiler. However, it is the practice at some shops to apply the wood lagging directly to the surface of the boiler with sheets of asbestos next to the boiler,—an advantage, as it assists in preventing radiation and the wood from charring. A coat of whitewash or plaster paris,—preferably the latter, as it is a good non-conductor,—applied to the shell of the boiler, prevents corrosion. The general practice is to omit covering the boiler head and the sides and front of a fire-box. Although this is done on some railways, it is the exception, and not the rule."

To lessen the difficulty and expense of lagging the sides of locomotive fire-boxes, plastic coverings are recommended. Many of these now in market are excellent non-conductors of heat, can be easily applied, and are reasonably durable in use. Coverings composed of hair, felt, or other organic fiber are objectionable for locomotives, and in general they are subject to decomposition when exposed to the action of high temperatures. "Wood covering is the cheapest, when we consider the first cost. For an eight-wheel locomotive, with a boiler 52 in. in diameter, the cost is: labor, $4.00; material, $7.10; total, $11.10. For the boiler of a consolidation locomotive, 60 in. in diameter, the cost is: labor, $6.75; material, $10.25; total, $17.00. Wood is undoubtedly the most costly covering, however, as it rapidly deteriorates by heat. All those in charge of locomotives doubtless realize the fact that we should have a boiler covering more efficient than wood to prevent radiation, and as readily applied and removed, and at a reasonable cost." Mineral fibre makes a good covering, but the sulphur sometimes contained in it is apt to attack iron more or less. On the whole, sectional composite coverings are considered as meeting the requirements more fully than any others, but the first cost of such a covering would be from $65 to $80, or nearly three times as much as the maximum cost of the common wood covering.

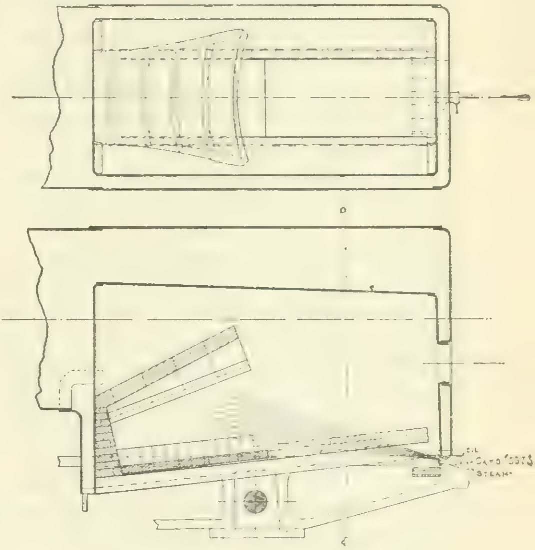
Oil Fuel for Locomotives.

RECENT experiments at the Baldwin Locomotive Works, directed to the utilization of oil as fuel for locomotives, are described in the *Railway Age* (Feb. 8), with illustrations herewith given. It is stated that the experiments were made on "what is considered the largest and worst type of locomotive,—compound No. 82, with 14-in. and 24-in. by 24-in. cylinders, and a long, narrow, and shallow fire-box.

"Two arrangements were made. In the first case (Fig. 1) the nozzle was in the place of the fire-box door. The grates were removed, and a 4-in. wall of bricks placed next the side sheets the whole length of the fire-box and at the ends. The bottom of the fire-box was covered over about half way back from the tube sheet and for about 18 in. at the back end. With this arrangement a trip was made from Philadelphia to Perkiomen junction, 25.7 miles, hauling a regular train. The engine burned the petroleum freely without smoke, and steamed freely, but, on account of frequent stoppages, it could not be tested for endurance. Another test was made, in which the burner was placed below the fire door, attached to the mud ring of the fire-box, as in Fig. 2. The line of spray was upward at an angle into the fire-box. The brick arch was lowered, giving more space between it and the crown-sheet. The bricks at the bottom were also removed, and a number of grate bars replaced. These were covered with fire-bricks. This arrangement was, by preliminary experiment, shown to be the best of all, and a final trip was made from Wayne junction to Port Reading, 52.3 miles, hauling twenty-seven cars, all but one loaded with coal."



OIL FUEL FOR LOCOMOTIVES. FIG. 1.



OIL FUEL FOR LOCOMOTIVES. FIG. 2.

The time occupied in making this run, including stops, was 3h., 20m., the actual running time being 2h., 48m., 9s. The water evaporated per pound of oil consumed was 10.58 lbs. The equivalent weight of water at 212° F. represented in this evaporation was 12.5 lbs. per pound of oil consumed. The oil burned per sq. ft. of grate surface was 132.25 lbs., or 39.68 lbs. per hour. The water evaporated per sq. ft. of heating surface per hour was 5.54 lbs., the equivalent at 212° F. being 6.55 lbs. An average steam pressure of 170 lbs. was maintained. The train comprised twenty-six cars, weighing a total of 661 tons of 2240 lbs. From the results of the tests it has been concluded that a safe rule would be to give 1 in. in width of burner to each sq. ft. of heating surface.

Forfeiture of Charter.

THE decision of Judge Gaynor as to the obligations of railway companies to maintain their service regardless of the fact that they are unable to engage employees at some prescribed rate of wages has been variously received, according to various interests and prejudices. We did not understand the language of that decision to mean that there could be no legal excuse whatever for the cessation of service by a railway corporation, or that an effectual obstructive interference of a mob with an honest effort to operate a railway would not be such an excuse. The decision did say that the simple fact that men could not be employed at wages which the corporations were willing to pay was not enough to justify an interruption of traffic, the first duty of the companies being to the public, and the interests of the stockholders being secondary to this paramount obligation. We do not think this position can be successfully assailed.

Mr. R. D. Fisher in the *Street Railway Gazette* (Feb. 9), however, interprets Judge Gaynor's decision as applying to the "inability to operate street railways on account of mob violence occasioned and participated in by organized strikers and their sympathizers." He says:

"It is apparent from the temper of the people and the tendency of the times that it would be impossible to operate any railroad in this country, were the law to be rigidly enforced that a road must forfeit its charter if, even for a given number of hours, it failed to run its cars. Such a law would place such companies at the mercy of strikers, and such a ruling would be fallacious, unwarranted, and of such strange legal blindness as to occasion friends of law and order extreme anxiety. Seldom has this popular dislike been more flagrantly reflected from the bench in an attempt to deprive a corporation, operating under a public franchise, of its legal rights. If courts hold that a street-railway corporation, operating under a public franchise, cannot contract for its labor like any other employer, but, instead, must pay what its employees demand, no matter at what sacrifice, lest its service to the public should be impaired, few persons would care to invest money in a plant secured by a public franchise."

We do not believe there is a judge living who would thus interpret the law. Certainly the quotation grossly misrepresents the decision in question. The latter nowhere disputes the right of corporations to contract for labor on the same basis as an individual might do. But, if railways refuse the demands of their employees, and obstinately refuse any concessions, and organized labor refuses longer to work under terms hitherto accepted, the companies must be ready to promptly continue the public service in a reasonably adequate manner, without the help of its former force. This interpretation of the law of corporations has not the slightest relation to mob rule, and does not justify what Mr. Fisher says in the remarks above quoted.

Again he says: "To hold that, if a company cannot secure employees at prescribed wages, it is bound to secure them at any price in order to operate its cars is a most unfortunate utterance from the bench." Why unfortunate? Has a company the right to take the opposite course, and, unless it can get help at any price it chooses to name, refuse to operate its cars indefinitely, regardless of the interests and convenience of the public it has undertaken to serve? Where is the middle ground between these alternatives? A railway company is a public servant. It has contracted to perform certain duties to the public, in consideration of certain privileges the public has granted to it. If it breaks its contract, shall not the public have the same right that an individual would have under similar circumstances to declare the contract void through failure of one of the parties to meet the requirements of the agreement? Or are the terms of a contract by and between a railway corporation and the State binding upon the State only?

The public already has enough to fear from the encroachments of badly managed corporations without such a strained construction of existing statutes, however agreeable it might be to the companies. The history of judicial action with reference to railway corporations proves that railway companies have no more to fear from judicial utterances than the public has, or is likely to have.

The Brott Electric Bicycle Railway.

FROM New York to Washington in eight hours is the speed proposed by the promoters of this scheme. *The Inventive Age* puts it as follows: "Rapid transit with more speed than the hurricane, the birds of passage, or the proposed air ships, is what is stipulated in the bill now pending in congress, which incorporates a company to construct this bicycle railway from the capital of the nation to the city of New York, the commercial and financial center of the country." This burst of eloquence recalls to memory the rhetoric with which arguments in favor of the Boynton bicycle railway have been presented. It is fair to say, however, that, with electricity as the motive power, the bicycle railway system becomes much more feasible than with steam locomotives,—a fact alluded to on page 172, Vol. VIII, of this magazine. But, when a speed of 120 miles an hour is proposed, it makes one draw a long breath. Some unforeseen difficulties, we opine, will have to be overcome before such a speed can be maintained on a railway of this length by any kind of motor yet in existence. This speed implies a velocity of 176 ft. per second, at which a body moving directly upward would move against gravity, and without further application of power, through a further distance of 100 ft. In other words, it is very closely the velocity at which a body falling freely would acquire in 5½ seconds. A sudden stoppage, when running at this speed, would produce effects hitherto unprecedented in the history of railway accidents. But it is perhaps possible to so construct railways and machinery as to render accidents highly improbable and of extremely rare occurrence, and, after all, it is better to be killed outright than to be half-killed and linger out a miserable existence afterwards. The electric bicycle railway may become a fact, but we do not expect to live to see cars running at 120 miles per hour by any now-known mode of propulsion.

IN describing a new tubular frame car, *The Railroad Car Journal* assigns as the reason for the prevailing unpopularity of this class of cars with railroad men, the difficulties of repairing wrecked cars. This reason will appear to the lay mind both grim and humorous.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

29110. Timber Preserving Methods and Appliances. Ill. W. G. Curtis (R G–Feb. 8.) 4000 w.

*29144. Economy in Railway Operation. L. F. Loree (E Mag–April.) 4000 w.

29186. Forfeiture of Charter. R. D. Fisher (S R G–Feb. 9.) 1800 w.

29227. Test of Fuel Oil for Locomotives at the Baldwin Locomotive Works. Ill. (R A–Feb. 8.) 600 w.

*29244. The Light Railway Conference,—Recommendation for Legislation (Tr–Feb. 1.) 3800 w.

29257. A New Tubular Frame Car. Ill. Church and Ettenger (R C J–Feb.) 1600 w.

29258. Electrical Car Heating. George Huyter (R C J–Feb.) 500 w.

29259. Some Past Experiences, Present Problems, and Future Prospects of the Railroad Car Painters' Trade. Charles E. Copp. Read before N. Eng. R. R. Club (R C J–Feb.) 3000 w.

29260. The Diamond Pressed Steel Bolster. Ill. (R C J–Feb) 1200 w.

29261. Some Views on Legislative Interference with Rates. L. S. Coffin (R R–Feb. 9.) 1500 w.

29264. The Railroad Stationer. Editorial (R R–Feb. 9.) 1000 w.

29266. The Gas Motor Street Car in Service. Report of Frank H. Mason (E R N Y–Feb. 13.) 2000 w.

29268. Low Rail Joints of Street Railways and their Prevention. N. S. Amstutz (E N Y–Feb. 13.) 2300 w.

29308. The Brott Electric Bicycle Railway.

We supply copies of these articles. See introductory.

—One Hundred and Twenty Miles an Hour Between Washington and New York. Ill. (I Age –Feb.) 900 w.

29309. The Possibility of High Speed Railways. F. L. Averill (I Age–Feb.) 1300 w.

29312. Massachusetts Railroad Commissioners Report (R G–Feb. 15.) 1200 w.

29313. The Law of Standing and Voting Trusts. Editorial (R G–Feb. 15.) 2100 w.

29314. The Advantages of Large Grates. Editorial (R G–Feb. 15.) 2300 w.

†29347. The Madras Railway. Editorial (I E–Jan. 12.)800 w.

*29354. Victorian Coal and the Victorian Railways. Quid Nunc (A M S–Jan. 5.) 3000 w.

*29366. The Stores Department of the North British Railway. Ill. A. E. Lockyer (R W–Feb.) 2000 w.

*29367. London Suburban Tank Engines. Ill. (R W–Feb.) 1800 w.

*29368. American Express Locomotives. Ill. Clement E. Stretton (R W–Feb.) 1200 w.

29370. Examination of Motormen and Conductors for Sight and Hearing. Wheelock Rider (S R G–Feb. 16.) 800 w.

*29381. Overhead Construction in Chicago. —Not How Cheap, But How Good. Ill. (S R R–Feb.) 2000 w.

*29382. The Middletown Goshen Traction Company. Ill. (S R R–Feb.) 1800 w.

*29383. Some Early Types of Track Construction. Ill. (S R R–Feb.) 700 w.

29395. Sunday Trains. L. S. Coffin (R R–Feb. 16.) 1000 w.

29396. Boiler Covering. E. A. Williams (R A–Feb. 15.) 1200 w.

29402. The Constructive Features of Transmission Lines. Ill. Arthur Vaughan Abbott (E E–Feb.) 11700 w.

*29419. Light Railways and Parliament. Editorial (E–Feb. 8.) 3000 w.

*29458. The Light Railway Question.—The Decauville System (Tr–Feb. 8.) 3000 w.

*29462. The Commercial Value of Electricity, as Applied to Tramways. By a Tramway Engineer (Eng L–Feb. 8.) 1700 w.

29519. The Macpherson Switch and Movable Frog ; Canadian Pacific Railway. Ill. (E N–Feb. 21.) 1200 w.

29521. Reasonable Railway Rates. Editorial (E N–Feb. 21.) 2000 w.

29539 The Class "P" Locomotive and the Pennsylvania Railroad. Ill. With Editorial (R G–Feb. 22.) 1800 w.

29540. The Rotary Snow Plow on the New York Central (R G–Feb. 22.) 800 w.

29541. A Report on a Balanced Locomotive. Ill. George S. Morison (R G–Feb. 22.) 1800 w.

29542. Railroad Renewals. Ill. Joseph O. Osgood. (R G–Feb. 22.) 1000 w.

29543. The Pacific Railroad Debt. Editorial (R G–Feb. 22) 1800 w.

*29593. Underground Railway in London. A. E. Daniell (Ch–March) 2800 w.

†27595. Rail-Bonding and Its Bearing on Electrolytic Corrosion. Ill. George P. Low (T A I E E–Feb.) 4800 w.

29613. The Recent Blizzard.—Snow Fences and Snow Plows. Zero (R A–Feb. 22.) 1400 w.

*29626. Light Railways. W. M. Acworth, with Discussion (J S A–Feb. 15.) 12800 w.

29653. Railway Earnings and Income. Report of Henry C. Adams (R R–Feb. 23.) 1600 w.

29654. Notes on Culvert Pipe. Ill. Julien A. Hall (R R–Feb. 23.) 1500 w.

29655. Excessive Train Service. Editorial (R R–Feb. 23.) 1000 w.

29656. Reduced Rates as a Factor in the Increase of Traffic. Editorial (R R–Feb. 23.) 1200 w.

29657. A Sensible View of the Pacific Railroad Question. Joseph Nimmo, Jr. (R R–Feb. 23.) 2400 w.

29658. The Kalamazoo New Railway "Safety." Ill. (R R–Feb. 23.) 1100 w.

29659. Railway Time Cards. Clement E. Stretton (R R–Feb. 23.) 900 w.

29661.—$1. The Pacific Railway Debts. R. T. Colburn (An A A–March.) 6000 w.

*29668. The Comparative Conditions and Cost of Transport by Railway and Canal. J. Stephen Jeans (I C T–Feb. 15.) 3000 w.

29684. Mountain Railways. Abstracts of papers by S. J. Berg, Alfred Collett and C. A. W. Pownall (Ir Age–Feb. 28.) 2200 w.

29696. Best Form of Draft Sheet for Fuel Economy in Locomotives. Ill. (E N–Feb. 28.) 1300 w.

29705. A Formula for the Maximum Train Load. L. G. Haas (R G–March 1.) 600 w.

29706. How to Live Without a Pool. Editorial (R G–March. 1.) 2000 w.

*29728. Petroleum for Locomotive Fuel. With Letter from James Holden (N C B–March.) 1800 w.

*29729. Adding Larger Boilers to Old Locomotives. With Letter from Francis R. F. Brown (N C B–March.) 1000 w.

29735. The Railroad Problem. Editorial (T–March 1.) 1300 w.

*29738. The St. Louis Extension of the St. Louis, Keokuk and Northwestern Railroad. Ill. B. L. Crosby (J A E S–Jan.) 7500 w.

*29756. The Electric Street Railway of Budapest.—An Object Lesson for American Cities. Ill. Anon. (R of R–March.) 1300 w.

29763 Needed Restrictions upon Electric Railways. Editorial, with Extracts from Report of the Connecticut Board (R A–March 1.) 1100 w.

29773. Suggestions for Street Railway Regulation in Brooklyn.—Report of Committee (S R G–March 2.) 900 w.

*29774. Possible Sources of Fuel Economy in Locomotives. Editorial on Mr. Forsyth's Paper (A E R J–March.) 3000 w.

†29783. The Street Railway System of Buffalo. Ill. (S R J–March.) 4000 w.

†29785. The Manufacture of the Modern Electric Car Wheel. Ill. P. H. Griffin (S R J–March.) 3000 w.

†29786. The Snow and Wreckage System of the Chicago City Railway Company. Interview with M. K. Bowen (S R J–March.) 2000 w.

†29787. The Rail Joint Problem. Ill. C. E. Mark (S R J–March.) 1000 w.

†29788. Method of Patching a Heavy Split Gear. Ill. Devised by Robert J. Hill (S R J–March.) 400 w.

†29789. Novel Power Station Construction, Columbus, O. Ill. (S R J–March.) 2400 w.

†29790. Prospects for Cable and Electric Traction in England. Alexander McCallum (S R J–March.) 1000 w.

*29796. The Future of Electric Traction in This Country. Ill. Philip Dawson (E R L–Feb. 22.) 1700 w.

*29801. Indian Railway Extension. Editorial (R'y T–Feb. 23.) 1300 w.

*29808. The Economy of Colonial Railway Management. Editorial (E–Feb. 22.) 3000 w.

*29813. American Rail and Tram Ways. Jeremiah Head, with Discussion (C G–Feb. 22.) 3800 w.

*29816. The Life of Railway Axles. Thomas Andrews (Eng L–Feb. 22.) 2500 w.

*29822. Light Railways. Arthur C. Pain, with Discussion (Eng L–Feb. 22.) 5000 w.

29841. An Open Letter and Reply Concerning Track Bolts. Letter—Jerry Sullivan. Reply—J. N. Barr (R R–March 2.) 900 w.

29842. National Arbitration Bill, with Editorial (R R–March 2.) 2600 w.

29843. "Hole in the Wall"—Interlocking Installation, Victoria Terminus, London. Ill. (R R–March 2.) 900 w.

29844. A Wrecking Outfit. Extract from paper by W. L. Derr (R R–March 2.) 1100 w.

†29882. Railway Passenger Fares. Editorial (I Eng–Feb. 2.) 1200 w.

*29903. Car Lubrication. B. Haskell (L E–March.) 2500 w.

*29904. Loose Methods in Purchasing Coal. Editorial (L E–March.) 1200 w.

*29905. The Fuel Record Farce. Editorial (L E–March.) 1200 w.

*29906. Broken Rails. Joseph Anthony (L E–March.) 2800 w.

*29907. Some Things to Consider in Changing the Rules of Interchange (L E–March.) 1700 w.

*29908. Lubricators. George Royal (L E–March) 1800 w.

29928. Test of a New Design of Electric Railway Power Station. George W. Colles, Jr. and Edward B. Gallaher (E N–March 7.) 6600 w.

29929. State Regulation and Valuation of Railways in Texas. Editorial (E N–March 7.) 2000 w.

29931. Logging Roads. Editorial (E & C–March 1.) 1500 w.

29932. The Weaver Grate. Ill. (R G–March 8.) 2500 w.

29933. The Rules of Interchange (R G–March 8.) 600 w.

29936. Train Resistance, with Editorial R G–March 8.) 2000 w.

Serials.

17826. Evolution of the Air Brake. Ill. Paul Synnestvedt (R E M–Began Dec., 1893—13 parts to date—15 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M–Began Jan. 1894—11 parts to date—15 cts. each).

24586. Railway Companies and Their Employés. O. D. Ashley (R A–Began Aug. 24—9 parts to date—15 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R–Began Aug. 25—26 parts to date—15 cts. each).

27850. What Street Railways Can Learn from Steam Railroads (S R R–Began Dec.—2 parts to date—30 cts. each).

28138. Block Signalling. Ill. W. H. Elliott (L E–Began Jan.—3 parts to date—30 cts. each).

28304. Signals and Signaling. Ill. (R R–Began Jan. 5—7 parts to date—15 cts. each).

28496. Electric Traction. Philip Dawson (E–Began Jan. 4—7 parts to date—30 cts. each).

28632. Light Railways. W. M. Acworth (P Eng–Began Jan. 11—Ended Feb. 1—4 parts—30 cts. each).

28897. Motor Repairs. Ill. W. E. Shepard (S R J–Began Feb.—2 parts to date—45 cts. each).

29109. The Systematic Improvement of the Lake Shore and Michigan Southern Railway. Benjamin Reece (R G–Began Feb. 8—2 parts to date—15 cts. each).

29175. On Electric Cable Railways. Ill. C. S. Du Riche Preller (E–Began Feb. 1—2 parts to date—30 cts. each).

29369. Tramway Management. By a Manager (R W–Began Feb.—1 part to date—30 cts).

29377. A Method of Permanently Protecting Underground Pipes from Electrolytic Corrosion. Harold P. Brown (A G L J–Began Feb. 18—Ended Feb. 25—2 parts—15 cts. each).

29384. Street Railway Wheel Threads and Flanges. Is a Standard Desirable? Anon. (S R R–Began Feb.—1 part to date—30 cts).

29667. An Australian Record of Railway Economy. Editorial (I C T–Began Feb. 15—2 parts to date—30 cts. each).

29775. Yard Arrangements Along Heavy-Traffic High Speed Railroads. A. Flamanche (A E R J–Began March—1 part to date—30 cts).

29840. Travels of the World's Transportation Commission. Clement F. Street (R R–Began March 2—1 part to date—15 cts).

29881. Light Railways. J. Walwyn (I Eng–Began Feb. 2—1 part to date—45 cts).

SCIENTIFIC MISCELLANY

University Education for Engineers.

VERY seldom is a lecture dealing with an educational subject so filled with strong meat, so spiced with humorous similitudes, and so flavored with literary merit as is one entitled "The Broader View," recently delivered by Mr. G. W. Dickie before the engineering students of Stanford University, and printed in full in *The Sibley Journal of Engineering*. The selection of any part of this lecture for quotation seems a slight to every other part, all being of value and interest. Yet we must do this, or abandon the purpose of reviewing one of the soundest, most helpful addresses to engineering students we have ever met with.

The lecture starts out with the broad proposition that men cannot be taught to be engineers. "No professor of engineering, no matter how wise a teacher he may be, can do that. They can teach you a great many things that is very important for an engineer to know, but, in acquiring all knowledge possible from the physical and scientific investigations made in the laboratory or lecture-room, do not forget that it is not so much what you know, but what you do, that will make you an engineer."

In speaking of the disappointments suffered by graduates in their first efforts to take their places in the active actual work of the period, it is shown, however, that the university course is not regarded as of small value because it cannot alone make successful engineers. "It is hard for the university graduate who enters an industrial establishment to feel his carefully-acquired stock of exact knowledge is not the commercial article, and is not held in very high esteem by those with whom he now associates. The head draughtsman under whom he works may be entirely innocent of the knowledge that he has acquired. He may even use bad grammar in his explanations of the work in hand. In every point taken separately, he, the university graduate, may be the superior of those far above him as an engineer; and he is apt to feel that his training is all mistake, and is a hindrance instead of a help. But as his power of comprehending the nature of things grows and develops with the experience that comes through the practical application of the principles and laws he learned the nature of as a student, he will find that the time spent at his university will continually grow in importance as he himself advances."

Of the designs made as exercises in the course for educational purposes it is said: "Yet, after all this care and calculation, you are surprised to find, on comparing this ideal design with what is accepted as the best practice in machinery to perform the same functions, that there is little or no resemblance between them, and the great danger to you lies in the tendency to a conclusion in your mind that the reason of this difference is entirely due to the ignorance of the practical engineer whose designs are so confidently accepted by his clients." This is a saying which may well be pondered carefully by all students of engineering, as cautioning them against the error into which they are most likely to fall at the commencement of their active career,—an error which in some cases unfortunately persists to the permanent injury of many a young man who otherwise might have risen rapidly in his profession.

Here is another wise caution. "The mechanical student, in producing a machine design from his calculations of what each part should be, is likely to find a 'machinikin' as the result. In such condition work is not ready to be shown in public. It would be an indecent exposure of the design to show it thus. Get some clothes upon it. Look up the works of the best masters in the same line of mechanism. Try to comprehend why their work is so unlike yours. Leave your figuring for a little while, and take a general view of what others have been led by experience to adopt. This will not, of course, give you experience, but it will remove from your mind some conditions that may very much delay your chance of acquiring experience, and it will enable you to go back to your design and fit a decent dress upon it, so that it may make a creditable appearance in mechanical society. . . . Another faculty of great importance to the engineer is that of being able to get most out of his eyes. An old foreman with whom I worked when a young man, when asked for instructions in regard to filling in work between two fixed points, was in the habit of saying: "Make it eye-sweet, my son, make it eye-sweet." I thought at the time that it was simply a habit that the old man had fallen into, but I have learned better since."

Finally, as to the real value of university training, Mr. Dickie takes a leaf from his own experience. "Some parts of what I have been saying might be taken to mean that I had but little faith in university training for the engineer. Such a conclusion would be a great mistake, and I would much rather not have addressed you than to leave such an impression on your minds. I would give a great deal to-day to be able to say that I had the advantage of a university training in the science of engineering. Many times I have struggled painfully through an engineering problem involving the use of, to me, intricate mathematical equations that to you would be very easy work, and I have wasted years in gathering up unaided only fragments of what you should have the whole of when you graduate from this institution. What I have gathered has been only what was absolutely necessary to meet my wants as an engineer, and many a time have I had to go hungry for the knowledge that would have lightened my labors. I am therefore not only in favor of the present course of engineering as given in the universities, but of extending it, and making it broad enough to embrace more practical work. Above all, I would like to see the students come from universities with clear ideas as to the practical application of the principles and laws that underlie all kinds of engineering construction."

Argon, the New Element.

In this department for February mention was made of the supposed new element existing in the air, recently discovered by Lord Rayleigh and Prof. Ramsey. The papers read before the Royal Society on January 31, upon this gas, to which the name "argon" has been given provisionally, have attracted worldwide attention, and the subject is now under active discussion in scientific circles. *Nature* (Feb. 7) accepts the discovery as valid "beyond doubt or question." So does *The Engineer* (London, Feb. 8). *The Electrical Review* (Feb. 8), on the contrary, regards the existence of a hitherto unknown substance in the atmosphere as yet in doubt, and it gives a very good reason for doubting. In fact, there are several very puzzling things about argon, if we admit that there is such a substance, and perhaps some of our hitherto accepted theories will now have to be revised. The evidence of its existence seems convincing to us, notwithstanding the scepticism still remaining in some quarters. However, we have learned to respect scepticism in matters of science, and cannot approve the following criticism from *The Engineer* directed at those who had the temerity to doubt the existence of argon upon the first announcement made at the meeting of the British Association at Oxford: "Those who, with a temerity not according to knowledge, were hasty in belittling with shallow, half-baked criticism the original pronouncement of two observers, honest, competent, and candid, are reduced to the silence which would have befitted them at first." With all respect, we deem this criticism ill-judged. *The Electrical Review*, as above intimated, makes it plain in the following quotations that there is evidence against, as well as for, the existence of argon:

"The large, distinguished, and unprecedented meeting of the Royal Society of January 31 received the paper on 'Argon: A New Constituent of the Atmosphere' with enthusiasm; and, although so many eminent personages were there, the absolute failure of the faculty of criticism on that occasion forms one of the most curious episodes in the history of the Royal Society of London.

"The facts as up to the present time disclosed by Lord Rayleigh and Prof. Ramsey are as follows: the weight of a liter of atmospheric nitrogen at 0° C. and 760 mm. barometric pressure is 1.2572 grammes. The weight of a liter of nitrogen derived from niter or ammonia is 1.2505 grammes. The theory by which Rayleigh and Ramsey seek to explain this difference of 6.7 milligrammes between the weights of atmospheric nitrogen and of the nitrogen derived from niter is that the presence of argon in the atmosphere is the cause.

"Let us now see how far the experimental evidence bears out this theory. Argon, say its discoverers, is heavier than the nitrogen of niter, the relative weight of equal volumes of argon and nitrogen being 20 and 14. That is to say, one volume of argon weighs very nearly as much as one and a half volumes of nitrogen. Now, in order that the excess of density of atmospheric nitrogen over niter-nitrogen may be accounted for, the amount of argon in atmospheric nitrogen must reach 1 per cent. by volume. Indeed, in strictness, a little more than 1 per cent. is demanded. According to Rayleigh and Ramsey, metallic magnesium possesses the property of combining with nitrogen at a bright red heat, and of refusing to combine with argon; and, by taking advantage of this property, they have brought out a method for the preparation of argon from air. In their paper they give instructions how to prepare argon by that method, and (what is more to the point) an example indicating the yield. They seem to have operated upon 100 or 150 liters of air, or, rather, of air from which the oxygen had been removed by red-hot copper in the well-known manner. In the actual experiment (the details of which they publish) the yield of argoniferous nitrogen was about 1500 c. c., which, of course, would be about 1 per cent. of the original atmospheric nitrogen. But now comes the remarkable fact: on further investigation, this 1½ liters did not turn out to be, approximately, pure argon. It was not even strongly argoniferous; it dwindled down to 200 c. c. on further treatment with metallic magnesium, and the 200 c. c. had a sp. gr. of 16.1, instead of 20, showing that only 70 c. c. was real argon. Thus actual experiment indicates that the real proportion of argon in the air is only about 0.05 per cent. by volume; and we are driven to the conclusion that the difference of density between the nitrogen of the air and the nitrogen derived from niter cannot be explained by the existence of argon in the air in the small proportion indicated by the actual extraction of the argon.

"Chemists with much practical experience in original research always attach importance to the yield of the new substance, and in cases where, as in the present instance, the yield of the new substance is only about one-twentieth of that which the theory requires, are inclined to regard the whole investigation with suspicion."

There are other reasons for doubt not given by *The Electrical Review*. *Nature*, notwithstanding its positive assertion of belief, above quoted, says: "Seldom have a series of facts and figures raised more important issues. The ratio of the specific heats" (under constant pressure and under constant volume) "is 1.66, which points to the conclusion that the substance is monatomic. If it is monatomic, it must be an element or a mixture of elements. If it is a single element, its atomic weight must be about 40, and in that case no place is ready for it in Mendeleeff's table. The easiest way out of the difficulty is to suppose that argon is a mixture" . . . etc. So it appears there are other theoretical points which may lead to doubt. Yet, if argon be truly a fact, the quotation from *The Engineer* which follows expresses the attitude which the scientific world must assume towards the discovery. "Nevertheless, belief in its validity must not induce any glossing of facts or straining of interpretation. In science the ascertained, experimentally-verified fact alone is sacred and permanent. Hypotheses—'laws' the unwise call them—are as but the dust of the balance when a fact is on the opposite pan; but be sure it is a fact. Recent as its introduction is to the society of recognized elements, argon is already the subject of the paralyzing inquiry: 'What is the use of it?' Let us say at once, and unmistakably, that there is no use for it, nor is there likely to be. The cynic philosopher, parodying Lord Melbourne's deathless remark anent the Garter, would say that one of the chief advantages of argon is that 'there's no d——d utility about it.' Without adopting this impregnable position, we are content to remark that any possible application that may, in spite of its exceeding inertness, be found for argon can scarcely be looked for within six months of its original isolation. A host of keen workers will doubtless turn to its investigation in all possible directions, and, if utility is to accrue, it will be arrived at in due time by their exertions."

Rain-Making.

It seems indeed remarkable, after it has been so thoroughly demonstrated that water is not precipitated from air unless the latter is at the point of saturation corresponding with its temperature, or is brought into content with some substance whose chemical affinity for water is greater than that of the air, that artificial rain-making should yet be deemed a possibility, and that a railroad corporation of hard-headed business men should be tempted to spend money in rain-making experiments. No doubt there is much need for a greater supply of water along the line of the Chicago, Rock Island & Pacific Railway. The locomotives of all railways require a regular supply, which must be obtained from some source,—not to speak of the stocks of many roads popularly credited with having absorbed more water than has been good for the stockholders. In view of these facts, the desire for an increased supply is entirely intelligible and justifiable. That a railroad company should be willing to spend money upon a process whose details are kept secret, and whose rationale (?) is unexplained, is without precedent. *Engineering News* (Feb. 14), rightly "conceiving it to be the office of a technical journal to publish information upon all subjects of technical interest, together with such comment as may aid its readers to clearly understand their significance," whether they be "fakes or otherwise," prints an account of the experiments and of the apparatus used on the road named, and also an editorial on the subject, which reviews the futile attempts at rain-making made by General Dyer on the plains of Texas, and the fallacy of the belief that led to them, and also indicates the "fake" character of the experiments on the railway above named.

The system (?) used is the device of one M. C. B. Jewell of Goodland, Kansas. Mr. Jewell has communicated to *Engineering News* an account of his apparatus. The method consists in injecting into the air a gas, or rather a mixture of gases, the nature of which Mr. Jewell keeps a profound secret. This is what he says in the communication referred to.

"The laboratory used in the field is a freight car, at one end of which three pipes project up through the roof. Each of these pipes divides into two pipes just inside the car, and the six pipes connect with six jars in which the gases are made." The letter continues: "On the opposite side of the car is a long shelf, on and under which we keep our materials. Directly over this shelf is a second shelf divided into thirteen compartments, in which rests our battery. At the end of the battery there is a large jug which is filled with a solution and is connected with the battery, which is also connected with the six large jars in which we make the gases. The tank on the top of the car is filled with water. This water we prepare before using, making it as soft as possible. The pipe near the left end of the car runs from the sink inside to a large hole dug in the ground to hold the waste. Sometimes this pipe is used as a ground connection from the battery. The other end of the car is partitioned off, and is used for a sleeping-apartment and office. My entire time is taken up while on the road answering correspondence, which comes from all parts of the world, and attending to the machine, which is operated day and night. I have used this process on the line of this road for two seasons. Last year I had three cars just like the one I send you a photograph of, and expect to have several more this year. Had there not been such hard times, several of the railroads in the arid regions would have used my process in 1894. My materials are furnished in Chicago by several different houses, and neither house knows what the other house furnishes, or which the other houses are. The men who operate the cars for me do not know what they are using, but simply follow my instructions. My process has been used sixty-six times, and at no time have I failed to produce rain; but at four places the rains were mere sprinkles, and were termed failures, and, to save argument, were so admitted by me. These failures are due to very high and changeable winds. There are no phenomena connected with these artificial rains any more than with a natural rain. All we do is to bring about the same conditions (?) which nature does when rain is produced, and, when we do this, a natural rain will fall. Nature and her laws are never wrong, and all efforts in this line must be in accordance with the laws of nature, or failure must follow."

Mr. J. B. Bailey of Phillipsburg, Kansas, writes to our contemporary with reference to experiments made at that place two years ago. "We were suffering for want of moisture, and I made application to our official department to have rain-maker Jewell come here and make a test. At about 2 p. m. he commenced operations. The skies were cloudless, and at about 5 p. m. the clouds began to appear, and at 9 p m. we had a rainfall of 0.78 in., as shown by the government gage. This included his first test at this point. The second test was followed by better results, there being a precipitation of 1 in. of rain. In the spring of 1894 we had him here again; the weather was cool, and the experiment was not a success, which I firmly believe was due to the unfavorable weather. The last experiment was conducted by H. Hutchinson, one of Mr. Jewell's substitutes, and who is not well versed in the science of electricity, which is an essential factor in tests of this nature. There is one point in your letter which I failed to answer, and that was the territory over which the rainfall extended. I would call it a local rain, as it did not extend over a radius exceeding 30 miles."

Mr. Whittemore of Belleville, Kansas, also writes: "Mr. Jewell gave us a fine shower in, I think, three days. He stationed one car at Mankato, one here, and one at Beatrice, Neb. We had a heavy rain from east of Beatrice to west of Mankato,—about 60 miles. I do not remember what the fall of water was, but I think it was 3½ in. I have all confidence in Mr. Jewell's power to produce rain." The broad and generous character of human credulity is, perhaps, as well exemplified in the acceptance of rain-makers' theories as in the facility with which any other humbug can gain supporters.

Wellner's Sail-Wheel Flying Machine.

AN article having the above title, by Helene Bonfort, in *Popular Science Monthly* for March, would have been better entitled "Modern Progress in Aeronautics," since only about one-third of it deals with Wellner's device, and the remainder discusses the general principles of flight, describes an apparatus entirely distinct from Wellner's and not even analogous to it, and briefly considers the work of the most distinguished investigators from the era of Gifford up to that of Lillenthal, Maxim, and Prof. Langley. However, the invention of Prof. G. Wellner of Brunn, Moravia, is the prominent feature of the paper. This is illustrated by engravings. It is described as follows:

"The essence of Prof. Wellner's innovation is his invention of the sail-wheel. It consists of a horizontally-placed axis, with spokes and arched aeroplanes attached to them in a cylindrical form. While revolving around the axis, the latter take a slightly slanting position, which causes the forward edges of these surfaces to be inclined, and consequently to compress the air in the way of a sail or a kite, calling into play the vertical force. Three ribs running across each lifting surface and made in the form of a screw at the same time serve to strengthen the aeroplanes."

"These sail-wheels, set in pairs, can be placed, according to the size of air-ship aimed at, in one or more groups of two wheels, revolving in opposite directions, behind or beside each other. The cigar-shaped car, furnished with a motor and carrying the aeronauts, is attached horizontally under the center of the wheels, so that the whole construction will resemble a colossal bird, propelled, instead of by wings, by revolving wheels, the lifting surfaces of which are consecutively and constantly developing vertical and horizontal power. The bird's movements in flying and the speedy headway motion necessary to the kite-flying machines for their support in the air are, in Prof. Wellner's invention, changed to a rotary motion. This construction, while permitting of an easy, slow ascent, assures the horizontal position and constant stability of the air-ship, at the same time permitting of a high velocity. The more the latter is increased, the stronger is the lifting power developed. The direction is given by a rudder at the end of the ship, or by increasing the velocity of the sail-wheels on one side only. It is the peculiar quality of these wheels that they do not, as might be supposed, disperse the air around them; they rather attract it toward their rapidly-moving surfaces, condensing it to a powerful stream, which passes down obliquely through their cylinders. Their velocity can be made to surpass by far that of railway trains, thus enabling them to conquer contrary winds and air currents. This flying-machine will hardly be called upon to rise above the cloud region; it will reach its goal on an air line at a moderate height above the earth."

It is claimed that two "steam engines of 20 h. p. each will produce during one hundred and eighty rotations per minute a velocity of 45 meters, a soaring speed of 15 meters per second, and a carrying power of 1500 kilogrammes." It is also stated that "some eminent European aëronauts—Profs. Pistio, Miller, Hauenfels, and Wellner himself—now favor the principle of partial disburdening by the application of some gas or other, which will add to the lifting power of the machine. This may be well enough in the present state of the art; but any satisfactory solution of the problem of flight must ultimately include the power to rise and alight independently of any such aid.

Effect of Forest Removal Upon Climate.

In "The Lesson of the Forest Fires," by Bela Hubbard, LL. D., in *Popular Science Monthly* for March, the author states that, though on some points scientists have not yet fully agreed, yet "the following propositions seem to be well established:

"(1) That the temperature is *hotter* in *summer* and *colder* in *winter* than when the country was covered with forests. This is a natural result of exposure of the soil to more active radiation and consequent frost. (2) The *winds have a more uninterrupted sweep*, and so the country is both dried up and refrigerated. (3) The *rainfall* is either *less in amount*, or its advantages are to a great degree lost. Forests retain the moisture that falls, and do not allow it to go to waste. (4) The *humus* in the soil, and the soil itself on the hills and slopes, are washed away by the rains, and carried to the lower lands and to the rivers, a large part being lost altogether." Abundant examples from the Old World might be adduced to fortify this position.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*29145. The Commercial Value of Weather Forecasts. E. B. Dunn(E Mag–April.) 2500 w.

29170. Heat Units. F. L. Slocum (A M & I W–Feb. 8.) 1300 w.

*29212. Peking. Thomas Child, with Discussion (J S A–Feb. 1.) 11500 w.

29275. New Jersey Clays: Their Classification and Adaptability to the Manufacture of Fire Brick. Charles Ferry (Ir Age–Feb. 14.) 1500 w.

29304. Compensation by Fees for Engineers. Editorial (E N–Feb. 14.) 1300 w.

29305. Can We Make It Rain? Editorial (E N–Feb. 14.) 1300 w.

29306. Rain Making on the Chicago, Rock Island and Pacific Railway (E N–Feb. 14.) 1400 w.

*29345. The Behavior of the Typhoid Bacillus and of the Bacillus Coli Communis in Potable Water. Dr. Percy Frankland (J G L–Feb. 5.) 4800 w.

†29364. The Financial Control of Government Engineers. Editorial (I Eng–Jan. 12.) 1200 w.

*29409. Argon, the Supposed New Element in the Atmosphere. Anon. (E R L–Feb. 8.) 600 w.

29439. Manual Training and Technical Education in Cleveland, O. Ill. E. P. Roberts (E W–Feb. 23.) 800 w.

*29461. Argon. (Eng L–Feb. 8.) 1600 w.

*29481. Argon. Editorial (N–Feb. 7.) 2300 w.

*29482. I. A New Constituent of the Atmosphere (Abstract). Lord Rayleigh. II. On the Spectra of Argon (Abstract). William Crookes. III. The Liquefaction and Solidification of Argon (Abstract). K. Olszewski (N–Feb .7.) 12000 w.

29494. Cold Storage and Cold Rooms from Compressed Air. G. D. Hiscox (Sc A S–Feb. 23.) 1500 w.

*29530. The Broader View. G. W. Dickie (S J E–Feb.) 3700 w.

*29594. Twenty-five Years of Geological Progress in Britain. Archibald Geikie (N–Feb. 14.) 3000 w.

†29687. Copper, Steel and Bank-Note Engraving. C. W. Dickinson, Jr. (P S M–March.) 7000 w.

†29689. The Scientific Work of Tyndall. Lord Rayleigh (P S M–March.) 4400 w.

†29715. The Appalachian Type of Folding in the White Mountain Range of Inyo County, California. Charles D. Wolcott (A J S–March.) 1400 w.

†29716. Notes on the Southern Ice Limit in Eastern Pennsylvania. Edward H. Williams (A J S–March.) 4800 w.

†29717. The Succession of Fossil Faunas at Springfield, Missouri. Steuart Weller (A J S–March.) 4200 w.

†29719. Drift Bowlders between the Mohawk and Susquehanna Rivers. Albert P. Brigham (A J S–March.) 5800 w.

*29799. Argon. J. H. Gladstone (N–Feb. 21.) 800 w.

*29809. An Engineering Laboratory for Glasgow University. Editorial (E–Feb. 22.) 1400 w.

*29811. The Competition in Coal. Editorial (F'y–Feb. 22.) 1500 w.

*29848. Village Communities in Southern India. C. Krishna Menon, with Discussion (J S A–Feb. 22.) 13500 w.

*29864. Marching Abreast in Science. From the English Mechanic (Inv–Feb. 23.) 2000 w

*29876. Philosophy of Wave Motion on Dams. E. R. Beardsley (Am M–March.) 1100 w.

†29918. Development of the Corallum in Favosites Forbesi. Variety Occidentalis. Ill. George H. Girty (A G–March.) 4000 w.

†49919. Early Protozoa. G. F. Matthew (A G–March.) 2200 w.

†29920. The Stratigraphic Base of the Taconic or Lower Cambrian. N. H. Winchell (A G–March.) 3500 w.

†29950. How to Organize the Union for Practical Progress in the Villages and Country Districts. Thomas E Will (A–March.) 6200 w.

†29951. Rubber Night at the Boot and Shoe Club (I R W–March 10.) 5000 w.

†29952. India-Rubber Horse-Shoe Pads. Ill. Gustave Heinsohn (I R W–March. 10.) 2300 w.

†29953. Why Rubber Tires Deteriorate. P. Carter Bell (I R W–March 10.) 1700 w.

†29954. Extraction of India-Rubber by Boiling (I R W–March 10.) 800 w.

Serials.

24462. Graphic Statics. Ill. W. W. F. Pullen (P Eng–Began Aug. 10—12 parts to date—30 cts. each).

25885. Engineering Lectures. Walter M. McFarland (Eng–Began Oct. 13—Ended Feb. 16—9 parts—15 cts. each).

26996. Statically Indeterminate Structures and the Principle of Least Work. Ill. (E–Began Nov. 9—5 parts to date—30 cts. each).

27198. Refrigerating and Ice-Making (S E–Began Nov.—4 parts to date—15 cts. each).

27548. Constructive Engineering on the Pacific Coast. (I S F–Began Dec.—4 parts to date—30 cts. each).

28231. The Animal as a Prime Mover R. H. Thurston (J F I–Began Jan.—Ended March—3 parts—45 cts. each).

28263. The Handling of Men. Foster Crowell (E R–Began Jan. 5—Ended Feb. 16—4 parts—15 cts. each).

28427. An American Engineer's Observations in Europe. J. F. Flagg (E R–Began Jan. 12—2 parts to date—15 cts. each).

28862. Distribution of the Echinoderms of Northeastern America. A. E. Verrill (A J S–Began Feb.—Ended March—2 parts—45 cts. each).

29082. The Second Lake Algonquin. Frank Bursley Taylor (A G–Began Feb.—Ended March—2 parts—45 cts. each).

29229. On the Calculation of Frameworks with Superfluous Parts. Ill. Max am Ende (Eng L–Began Feb. 1—Ended Feb. 15—2 parts—30 cts. each).

29531. A History of the Last Quarter Century in the United States. Ill. (Sc M–Began March—1 part to date—30 cts).

COMMENT & CRITICISM

Friction of Belting and Shafting.

SEVERAL articles have appeared in the recent issues of THE ENGINEERING MAGAZINE upon the subject of transmitting power by means of electricity, and I have read all with very much interest.

The writers of these articles, as well as writers for other technical and trade periodicals, have made some statements which convey a wrong impression to the mind of the reader. In the Feb. issue Prof. Anthony says: "the loss by friction of shafting and belting is constant whether the machinery it is intended to drive is in use or not. The diagrams in connection with his article show that he has taken the friction load of the engine and transmission machinery to be equal to the power required to drive them when the machines which they are intended to drive are idle and to be no greater when all the machines are running.

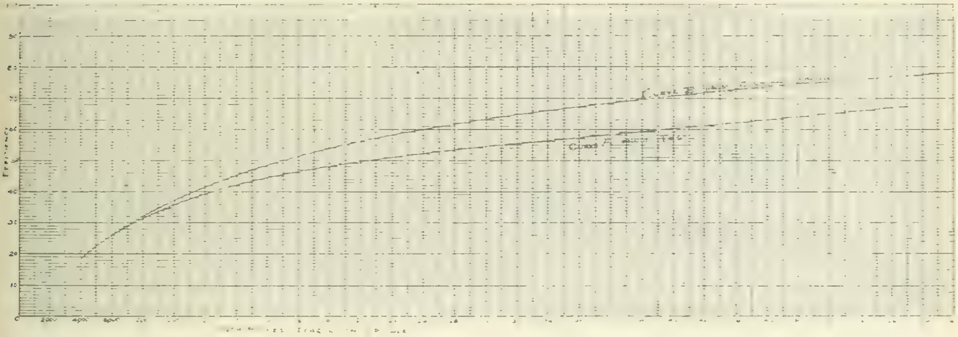


DIAGRAM. FRICTION OF SHAFTING AND BELTING.

In the table, quoted by both Messrs Richmond and McKissick, Prof. J. J. Flather gives as the percentage of loss due to the shafting that power which is rerequired to drive the shafting when the machines are idle.

From tests made by others, as well as from my own experience, I believe that I am justified in saying that these statements are incorrect, and that while there is a continual loss due to the shafting, the loss increases as the load on the machines increases and is greater when the machines are running than is shown by the table or diagrams.

The diagram which I send is from a test made by me of a 42″ triple-geared lathe. The curve *A* shows the efficiency of the driving mechanism with the slowest backgear and slowest cone-belt speed. From curve *A* we find that the power required to drive the mechanism itself when the torque on the spindle is 50,000 inch pounds is over one and one-half times greater than when the torque on the spindle is 6,000 inch pounds.

For certain reasons it happened that a reading was not taken with no load on the spindle, so that the comparison is not quite as good as it might be. Assuming, however, that the friction load is constant, as these writers have stated, and that in this lathe it is the same as represented when the tongue is 6,000 inch pounds, we obtain the curve *B*. This shows that a much higher efficiency would have been obtained than was actually found to be the case.

In a paper read before the American Society of Mechanical Engineers, several years ago, on "Transmitting Power through

Belts" Mr. Wilfred Lewis says: "An interesting feature of these and subsequent experiments is the progressive increase in the sum of the belt tensions during an increase in load."

This would account for the increase of friction and power required to drive the transmitting mechanism, which I found to be the case in the tests that I made. The increase in the sum of the belt tensions causes increased bearing pressure and increased losses by friction.

Being a firm believer in the economy and convenience of using electricity for transmitting power, and that belts and long lines of shafting should be discarded as rapidly as possible consistent with the circumstances in each case, I wish to add what I have here said to the arguments already made by others in favor of the electric motor.

DAN. C. WOODWARD.

Lynn, March 6, 1895.

Prof. Anthony's Reply to Mr. Woodward.

I HAVE just received the letter of Mr. Woodward, which you sent me for perusal and response. I see that my language quoted by Mr. Woodward does not express exactly what I had in mind. I meant that the friction losses, due to belting and shafting are continuous, not that they are invariable. This, in contradistinction to electrical transmission where almost the whole of the transmission losses ceases with the stopping of the machine.

I think, however, that my language, as Mr. Woodward understood it, is warranted as a general statement by the generally accepted facts as to the action of belting and shafting to be found in standard works. I have not the books by me, but am quite sure the statement is made in Rankine, and I know it is made in other works on machinery and belting, that, under ordinary conditions met with in practice, the pressure produced by a belt upon the journals is independent of the load, or nearly so, the tension of the slack side of the belt being diminished as much as that of the tight side is increased. Since the pressure on the journals is constant, the friction of shafting that continues to run when the load is off will be practically constant. The loss from the slipping of belts will increase with the load, but this should not be great if belts are properly proportioned to the power they have to transmit. The loss from the rigidity of the belt will vary but little with the load.

These results, arrived at by the accepted authorities on the subject, would warrant the general statement that the friction of all belting and shafting that continues to run when the load is off, is practically constant. Counter-shafting and belting that stop with the machines, represent a loss not accounted for by the indicator diagrams taken when machinery is stopped. This, as well as the loss due to continuously running shafting, would be saved in the case of direct driven machines, and where such counter-shafting and belting are present, the case is still more favorable to electric transmission than load diagrams taken like those given in my article, would show.

WM. A. ANTHONY.

New York, March 11, 1895.

Science vs. Nature.

WHILE the "boom" was on in Virginia a few years ago a well known mining engineer of Roanoke rode over to one of the border counties of Southwest Virginia to inspect and report upon a mineral property. Late one evening he rode up to a farm house and asked if he could get accommodations for the night. The grandmother of the household was the only person to be seen.

"Yes, I reckon we can put you somewhere; everybody's off ter meetin'; so ef you'll put yo' horse in the stable the children 'll feed it when they come."

After following her directions he returned to the house where the old lady asked him to "take a cheer and draw up nigh the fire."

She sat upon one side of a large open fireplace where a generous blaze was making a big tea-kettle hum. Presently she stopped knitting and asked abruptly "young man, what's yo' business?"

"I'm a mining man, mam; I look after

mines and into mineral deposits and things like that."

"Minerals? well, you've come to the right place, cert'n."

"Indeed, I am glad to know it, I suppose you know of mineral deposits in this locality?"

"No, I cain't say as I do, but God knows there ain't nothin' much on the *outside* of these here hills, so there must be somethin' on the *inside*, and, young man, don't yer know I think the flood must have been some'ers 'bout here?"

"What makes you think so, madam?"

"Because there was mo' water them days, and it washed the dirt off'n the hills."

"No, no madam, the flood was purely of local origin, and there is just as much water now as there was then, there is no loss of water on the earth, you know."

"No loss of water? Young man, do you mean to say that when that tea-kittle's filled with water and it all biles away that there's jes' as much water lef' as was befo'?"

"Yes'm, it is simply turned into steam; it is in the air where—"

"Do you mean to say that when Sallie takes er bucket er water and scrubs up this here flo', that there's jes' as much water as ever?"

"No, not that exactly, only the floor has absorbed it, and that in time it will evaporate into the air where—"

Just then the young people came bustling in from the meeting, and shortly afterwards they all sat down to the supper table where the engineer had the grandmother opposite him. She sat in perfect silence for some time watching him narrowly over her glasses till suddenly she startled the other members of the family with:

"*Young man, you're the bigges' liar I ever see.*"

R. A. MARR.

Aluminum, the Superabundant Metal.

WE have read with much interest the article in the December number of the ENGINEERING MAGAZINE on the above subject, and written by Mr. Henry Wurtz, Ph. D.

We cannot quite agree with this gentleman's statements that ultimately other clays will supplant bauxite. What will, however, be done, is the adoption of a more recent patent than that of the electrolysis process for the manufacture of aluminum. Aluminum will be made in this country, or in Ireland, by a process of fusion, and at considerably less cost than can be done by the electrolysis process. We know this from the fact that we have control of the largest bauxite producing mines in Ireland close to a point of shipment where there is plenty of water and cheap tonnage. Aluminum metal will be made from our Irish Hill bauxite very shortly at a very considerably reduced price that will beat all competition.

GEO. G. BLACKWELL, SONS & CO.
Liverpool, Eng.

A Definite Correction.

IN looking over the February, 1895, number of your magazine, we observe that on page 933 you give an extract of a paper in regard to water tube boilers for marine use, in which the Babcock & Wilcox boiler is classed among the bent tube boilers. This is a mistake, and we are indebted to you for your remark indicating that such classification was probably an inadvertence.

We will now ask you to make a definite correction in your next issue. We use nothing but straight tubes, open from end to end for purposes of cleaning both inside and out, and naturally we do not want to be classed with boilers made up on the macaroni style.

THE BABCOCK & WILCOX CO.
New York, March 18, 1895.

NEW BOOKS OF THE MONTH

ELECTRICAL BOATS AND NAVIGATION. By THOMAS Commerford Martin, Past President American Institute Electrical Engineers. and Editor of the Electrical Engineer, and Joseph Sachs, Member the N. Y. Electrical Society. and Associate Member A. I. E. E. New York: C. C. Shelley, Publisher, 1894. [8vo., 224 pp. Price, $2.50.]

ELECTRICAL navigation is yet in its early infancy, but much good experimental work has been done, and a considerable measure of success has been attained, especially with the smaller class of boats, such as electrical launches, &c. The author has endeavored to bring together the typical data relating to the art, and he claims to have gathered much information not hitherto published. A historical account is given in the first chapter, in which is also considered the subject of boats propelled by primary batteries. In the second chapter the subject of storage-battery boats is taken up, and in the final chapter, in addition to what is said of storage batteries in the first and second chapters, much information of general value, which of course is also of special value in the electrical propulsion of boats, is given. Thus the difference of conditions between the use of storage batteries on boats and on tramway cars is pointed out in a clear manner, illustrating some of the difficulties which have been encountered in the application of storage batteries to the purposes of propulsion, and showing that these are much less in the electrical propulsion of boats than they can possibly ever be on tramways. The use of storage batteries is shown to have become more and more absolute for purposes of propulsion, and the conditions for the successful use of the storage battery are well indicated. The work is profusely illustrated with many examples of practice in electrical propulsion, and the subject of dirigible electric torpedoes for warfare and life-saving is treated in a chapter by itself. The same may be said of the subject of electric submarine torpedo boats. Special features of storage launch operation and charging are the subject of another chapter. One of the most interesting chapters is devoted entirely to special electrical craft, rowboats, catamarans, and paddle-wheel boats. The authors acknowledge in the preface the assistance of Mr. J. C. Chamberlain, Mr. F. Reckenzaun, and Mr. Joseph Wetzler in the preparation of the work. In our judgment this book is destined to have a wide circulation, especially among electrical engineers and marine engineers.

MENTAL DEVELOPMENT IN THE CHILD AND THE RACE. Methods and Process. By James Mark Baldwin, M. A., Ph. D., Stuart Professor of Psychology in Princeton University, Author of "Handbook of Psychology," "Elements of Psychology," and Co-Editor of the *Psychological Review*. With 17 figures and 10 tables. New York and London: Macmillan & Co., 1895. [496 pp., 5″¼×7¾″, Cloth, Price $2.60.]

THE subject of mental development in the child and the race is very thoroughly treated in the light of modern science. Infant psychology and race psychology are treated, the one from the genetic point of view and the other with reference to the characteristic mental peculiarities of various peoples, tribes, stages of civilization, cults, etc. A feature of the author's treatment is the attention paid to experimental data obtained directly from observations of infants from the earliest age through their development to adult age. Though the scientific method is pursued throughout, no intelligent reader would have any difficulty in comprehending all the principles and expositions comprised in the dissertation.

NOTES ON RANKINE'S CIVIL ENGINEERING, AFTER THE Notes of Professors William Allan and G. W. C. Lee. By David C. Humphreys, C. E., Professor of Applied Mathematics, Washington and Lee University, Member of the Am. Soc. C. E., etc. Lexington, Virginia, 1894, 19th Edition. [184 pp., 9″×13¾″, Cloth, Price $4, post-paid. Sold by the author, Lexington, Virginia, and Charles Scribner's Sons, New York.]

CONSIDERING Rankine's "Civil Engineering" as the standard, an effort is made in this book to increase its popularity by the addition of these notes. Rankine's book is more of a manual than a text-book. Equations and formulæ are frequently employed without any demonstration of the manner in which they are obtained. The notes supplied by Professor Humphreys show the reasoning from which the equations are derived, and will enable Rankine's excellent treatise to be read and used with far greater satisfaction than it can be used in the form given to it by its eminent author.

Steam and the Marine Steam Engine. By John Yeo, Fleet Engineer Royal Navy, Fellow of the Royal School of Naval Architecture and Marine Engineering, Member of the Institution of Naval Architects, etc. London and New York: Macmillan & Co., 1894. [196 pp., 5½″ × 8¼″. Price $2.50.]

A condensation from lecture notes of Prof. Yeo, in which a sound general view of the subject, with as much detail as is thought necessary for the end in view, is conveyed in a brief and simple manner. The book is well up to date, including descriptions of the most modern steam engines and boilers employed for marine purposes.

Electrical Engineering for Electric Light Artisans and Students. (Embracing those branches prescribed in the syllabus issued by the city and Guild's Technical Institute.) By W. Slingo and A. Brooker. With 346 illustrations. New and revised edition. London: Longmans Green & Co., and New York, 1895. [753 pp., 5″×7¼″. Price $3.50.]

The original treatise of Slingo and Brooker on electrical engineering was justly regarded at the time it appeared as among the best ever published. To those who are familiar with that work and who have learned its value by use, it is enough to know, with reference to this edition, that it has been revised and brought up to date by the same authors.

A Text-Book of Volumetric Analysis, with special reference to the Volumetric process of the Pharmacopœia of the United States designed for the use of Pharmacists and Pharmaceutical students. By Henry W. Schimpf, Professor of Inorganic Chemistry in the Brooklyn College of Pharmacy, Food Inspector of the Department of Health of the City of Brooklyn, etc., etc. First edition. New York: John Wiley & Sons, 1894. [400 pp., 5″×7½″. Price $2.50.]

"Specially adapted for the use of Pharmacists" means that the book is also well adapted to use for anyone desiring to become familiar with the principles of volumetric analysis. Chapter 14, on the "Sanitary Analysis of Water," is a complete epitome of this subject, and will be useful to sanitary engineers. Many superintendents of industrial works who are required to know something of chemistry as well as engineering will find this work useful.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

Baker & Co., Newark, N. J., U. S. A.=Pamphlet and Catalogue, 38 p. [Considerably enlarged edition, containing information relative to platinum and its uses, with numerous cuts of platinum utensils and apparatus for metallurgical work. Also tables giving weights per foot of platinum wire in troy and French weights, with rules for determining the weights of corresponding sizes of wire in pure silver; wire gages; and a table of comparison of troy, Avoirdupois, and French weights. On the cover is an illustration of the gold, silver, and platinum refinery of the firm.]

Detroit Dry Dock Co., Detroit, Mich., U. S. A.=Pamphlet, 25 p. [Describes the performance of the steel steamer Harvey H. Brown, constructed by the company, in which, it is claimed, a cent's worth of fuel has transported a ton of cargo 170 miles at the rate of 13.2 miles per hour, as a result of Howdem's Hot Draft System. Also a mention of the saving of 33⅓% in fuel resulting from this system on the passenger-steamer Virginia; 6 full-page plates of indicator diagrams and two full-page tables of general results illustrate the text.]

Metropolitan Electric Co., Chicago, Ill., U. S. A.=(1) Street Railway Catalogue, 204 p., exclusive of cover. [An elegantly printed book, the contents of which require for their index a space of four closely-printed pages; cover, French gray and gilt. Comprehends substantially everything comprised in electric street railroading). (2) Pocket Catalogue of Insulators, 34 p. (Chrome lithograph engravings, with names and sizes.]

The Packard Family, New York & Ohio Co., Warren, Ohio, U. S. A.=Catalogue, 39 p. [Describes a full line of Packard incandescent lamps, both for high and low voltage, reflectors, sockets, street fixtures, transformers, and the Packard vacuum pump. Flexible cover, yellow and gilt.]

Keuffel & Esser Co.=Catalogue, 404 p. [Twenty-sixth edition re-written and revised and enlarged by more than 100 pages. Describes and illustrates one of the most extensive lines of drawing materials, drawing instruments, surveying and engineering instruments, carried by any firm in America. Also contains a great amount of explanatory matter relating to drawing materials and instruments, and to instruments used by engineers in general, such as planimeters, surveying instruments, verniers, leveling rods, aneroids and their use, field glasses, etc. Also contains half-tone views from photographs of the several departments of the store and factories of this firm.]

The Consolidated Telephone Construction and Maintenance Co., Limited, London, E. C., Eng.=Catalogue and Price List, 72 p., [Illustrates and describes the Consolidated Magneto-Telephone in its various forms, specially adapted for use in remote districts, and for desks; the Gower-Bell Telephone with vibrating bell, also with Gower-Bell transmitter and with bell-receivers ; the Gower-Bell for separate vibrating bell ; the Gower-Bell telephone with Hunning's transmitter for railway service ; battery bell combination with Blake's or Hunning's transmitter ; Hunning's transmitter on switch bell with receiver and cord ; the consolidated battery telephone ; the operators' telephone, containing receiver, transmitter, and circuit-closing key,—claimed to be the smallest key-instrument yet produced ; domestic telephone ; the Fitzgerald combination ; granulated carbon transmitter and receiver, pencil transmitter, annunciators, switch-board, magneto call and extension bells, switches, push-buttons, lightning arresters, batteries, cords, tools, &c.]

The Goulds Manufacturing Co., 16 Murray St., New York, U. S. A =Catalogue of Pumps and Hydraulic Machinery, illustrating and describing efficient power pumps for every variety of service. 96 p. [An important feature of this catalogue is its descriptions and illustrations of pumps driven by electric power. Elegantly printed on coated paper ; cover, lemon yellow, blue, and gold.]

Sherwood Manufacturing Co , 34 and 36 Washington Street, Buffalo, New York, U. S. A.=Catalogue, 24 large octavo p. [Describing the indicators, lubricators, engine and boiler supplies manufactured by this company. A unique feature among these descriptions is a water pressure ejector or cellar drainer, worked by water pressure, which is claimed to eject double the quantity of water that it takes to run it, and can be used to advantage in excavations, cellars, &c., where water pressure can be had, and the elevation required is not too high for the pressure obtained. A large variety of steam appliances are included in the catalogue, with price lists.]

The Walker Mfg. Co., Cleveland, Ohio, U. S. A.=Suggestions, Rules, and Tables on Electric Railway Work. [Pocket size ; 37 printed pages, with blank pages for memoranda, and containing convenient data and tables.]

Ohio Brass & Iron Manufacturing Co., Cleveland, Ohio, U. S. A.=Catalogue, 1894. 52 pp., 5½"×7¼". [Illustrates and describes the line of high-grade plumbers' brass goods, and the "Ohio Stops" manufactured by this company.]

The O. S. Kelly Co., Springfield, Ohio, U. S. A.=Portfolio, of engravings, 31 pp., 12"×16". [Showing the Springfield steam road roller manufactured by this company, in the hands of its users, making all kinds of roads throughout the United States ; also containing full detailed description of its construction. This is one of the finest trade publications received during the month. It is elegantly bound in salmon colored and gold cover, and the engravings are of unusual elegance both in their execution and arrangement. Important information relative to road rolling is also supplied in the text.]

Penberthy Injector Company, Detroit, Mich., U. S. A.=Catalogue, 35 pp., 9"×6". [Describes and illustrates the Penberthy automatic injector, with other steam specialties manufactured by this company, and also contains descriptions and price lists of a number of new water gages and oil cups, which this company are just placing on the market. The entire catalogue is printed in green on lemon yellow paper, and presents a beautiful appearance.]

J. H. Sternbergh & Son, Reading, Penn'a, U. S. A.=Catalogue 1895, 51 pp., 5½"×8". [Describes and illustrates the extensive line of bolts, nuts, washers, boiler rivets, bridge and ship rivets, lag-screws, turn-buckles, Harvey patent grip thread track bolts, soft steel bolts with cold pressed threads, rods and irons for bridges and buildings, etc., manufactured by this firm at Reading, and in the works of their branch establishment, the Kansas City Bolt and Nut Co., Kansas City, Mo. A frontispiece gives a view of the works. Price lists are included, which also give U. S. standard sizes. A list of sizes of merchant bar iron made in the rolling department of the works, and for which prices will be quoted on application, is also presented. Tables of sizes and proportions of the U. S. Standard Screw Threads and Nuts, dimensions of bolt heads, weights, etc., are appended.]

The Bradley Pulverizer Co., Boston, Mass., U. S. A.=Pamphlet, 27 pp., 9¼ × 6½". [Describes and illustrates "The Griffin Mill," for the reduction of rock and ores of all kinds to fine powder. Adds also specifications for 38" mill and an illustrated list of parts of the Griffin mill. 10 pages of testimonials are appended.]

W. E. Caldwell Co., Louisville, Ky., U. S. A.=Catalogue, 24 pp., 6" × 9". [Describes and illustrates the line of water tanks and iron water towers for railway and other purposes manufactured by this company, with price list. Also contains tables for computing the capacities of tanks and the strength of iron towers for supporting same. Details of construction are also given.]

The A. A. Griffing Iron Co , Jersey City, N. J., U. S. A.=Catalogue, 234 pp., 8"×5½". [Describes and illustrates the various styles of Bundy radiators for steam or hot water, and a long line of heating specialties manufactured by this company, with price lists. The catalogue is nicely printed and bound in two styles, one flexible with cream, carmine and gold cover, and the other stiff cloth cover.]

W. H. Drake, Hackettstown, N. J., U. S. A. =Catalogue, 24 pp., 9"×6". [Describes and illustrates the "Torrid" steam and hot water heater, with a list of parties who have these heaters in use, and a table of dimensions, heating power and price list.]

The Pennsylvania Brass Works, Erie, Penn'a, U. S. A.=Catalogue, No. 2, 1895, 16 pp., 6½"×5¼". [Describes and illustrates a line of whistle valves, air cocks, steam cocks, water gages, gage cocks, engine and boiler lubricators, brass oil cups, and other steam goods. Also a line of plain brass church decorations. Beautifully printed in blue on glazed paper, with cream and carmine cover.]

THE

ENGINEERING MAGAZINE

VOL. IX. MAY, 1895. No. 2.

MEANING OF THE RECENT UNITED STATES PATENT DECISION.

By Park Benjamin.

ANY one interested in a paying enterprise based upon the protection afforded by a patent naturally desires that the lifetime of that patent shall be as long as possible. When the patent underlies a great monopoly, the returns from which are huge and increasing, then, as may well be imagined, the last years of the patent term are regarded as much more valuable than the earlier ones; and the desire not to be deprived of protection at such a time becomes increased. When there is a number of such monopolies all similarly circumstanced, the aggregate bulk, so to speak, and the combined force of these several desires gets excessive; and, when such a deprivation or limitation appears imminent, then it is easily anticipated that appeals possessing great momentum will be made to legislature and court,—the first so to make or amend, the second so to construe or interpret, law as to avert the impending disaster.

The decision in the famous Bate refrigerating process case recently rendered by the supreme court of the United States is a consequence of the conditions above outlined. Several distinguished inventors had made inventions of merit. They had complied with all legal requirements and had secured patents of the United States, apparently granting them protection for the statutory term of 17 years. They had also obtained foreign patents for the same devices. But for various causes—sometimes purely fortuitous and beyond their control, such as unlooked-for delays in one patent office or especial expedition in another—it had come to pass that these foreign patents had been granted to them *before* the American ones.

Copyright, 1895, by the Engineering Magazine Company.

Hinc illæ lachrymæ. From this simple happening apparently grew all the trouble, and the appeal to the highest tribunal in the land.

The real source of the difficulty lies, however, not in the circumstance, but in the law; and more particularly in Section 4887 of the Revised Statutes* of the United States, which provides that, if you choose to apply for both American and foreign patents, the American patent will be granted on the condition that, if you obtain the foreign patent *first*, your invention shall be free to the American people whenever, by reason of the expiration of the foreign patent, it becomes free to people abroad. Observe that the person here aimed at was the foreign, and not the American, inventor; and the intention was to secure for our own people the free use of the foreigner's invention as soon as his own compatriots got it. In other words, as the diplomatists say, we claimed for ourselves the benefits of the "most favored nation."

But the intention of the law-makers and the effect of the law have not at all comported. The statute has proved a legislative boomerang which has recoiled upon ourselves, and its principal effect is and has been to limit the lifetime of the American patents of our own inventors to the often much shorter lifetimes of their previously-granted foreign patents; and, since many of these American patents lie at the foundation of great enterprises in this country, the losses to the owners and promoters thereof, incident to such limitation, are great and far-reaching. These are the more special circumstances surrounding the recent appeal to the supreme court.

As this troublesome statute existed in the Patent Act of 1870, and, in fact, became crystallized in the Revised Statutes of the United States before most of the patents affected at the present time were applied for, it may be urged that there is no apparent ground for complaint by the parties injured by it. They were not compelled to seek foreign patents, or to prosecute the latter so as to cause them to be granted at a date earlier than that of their American patents. Seemingly they chose to do this with the law before them, and therefore voluntarily placed themselves under the conditions which it imposed as the sequence of their act. But, on the other hand, it must be remembered that, at the period when perhaps most of the important patents now limited were sought, the great era of electrical development in this country had only just begun. People were then rushing in to get patents, chiefly for electric-lighting apparatus. Then came the invention of the telephone, which created still more intense interest in electrical subjects. A little later followed the storage battery, with all the glowing promises made concerning it. And thus, for several years, the rivalry among inventors in the electrical field was intense, their activity unprecedented, and the supposed rewards so great and so near at hand that it seemed that any delay in the securing of protection for new devices might well result in the loss of them to others. There was little time or desire, in those days, to discuss limitations of the patent grant or the relations of various patent grants to one another. To secure immediate protection ; to issue stock and sell it, and float companies, and realize profits,—these were the all-engrossing matters. To counsel caution merely evoked an answer picturing the immense gains to be secured at once from the invention, and expressing an entire willingness to leave the disastrous to-morrow to take care of itself.

---

* R. S., Sec. 4887. No person shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid, by reason of its having been first patented or caused to be patented in a foreign country, unless the same has been introduced into public use in the United States for more than two years prior to the application. *But every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent*, or, if there be more than one, at the same time with the one having the shortest term, and in no case shall it be in force more than 17 years.

"What do I care?" said one sanguine genius to me, after I had warned him of the effect of a foreign patent of but 5 years' duration, which he insisted upon obtaining. "Before that 5 years is up, I shall have made all I want of it, and there will be half a dozen generations of stockholders, in and out of the company, with their piles all made before that time comes. Let the people who own the thing then take care of themselves."

That, of course, was an extreme case, but, to a certain extent, it is typical. In the course of years the people who ultimately inherited these things found that they did have to "take care of themselves." Many of the inventions had long since gone out of the hands of individuals and into those of great corporations. The question of a man's right to his little profits for a few years more or less often became magnified into whether the public should continue to pay millions for the benefit of huge monopolies.

So the vast power of the latter began to work for their own salvation. Again and again they importuned for the repeal of the objectionable statute. Five bills were introduced into the fifty-third congress, all looking to the amendment of the law and all retroactive in their character. The effort was unavailing.

Meanwhile recourse was had to the courts, where alleged infringers pleaded the law in their defence, and from 1882 onward every effort was made to induce the judges to construe the statute to mean that the foreign patent, in order to have its limiting effect, must bear a date of grant prior to the date of *application* for the American patent ; so that it would then be nugatory in the great majority of cases where the foreign patent had been granted after the date of application for the

American patent, but before the date of grant thereof. The courts remained obdurate. In an unbroken series of decisions for nearly 13 years they construed Section 4887 by the plain import of its language.

As time went by, the immense growth of the electric corporations and the popular belief in the magnitude of their profits united to stimulate the public desire for free competition. Attempts to break down the incandescent-light patents of Mr. Edison failed. It was discovered that the expiration of the two fundamental telephone patents offered no certain release from the exactions of the controlling monopoly. After a sleep of 14 years in the patent office, the so-called Berliner patent was issued, and it was announced that this patent, together with others granted to Edison for a speaking telegraph, "covered fundamental inventions and embraced all forms of microphone transmitters and carbon telephones." Yet, if the statute meant what it plainly said, these patents had lapsed. But the corporations persistently asserted that the United States supreme court, whenever it should come to consider the question, would reverse the rulings of the lower courts and interpret Section 4887 favorably to their view of it. This was sufficiently potent seriously to check the growth of competing enterprises, although the effect of the doubt on the corporations themselves could be read easily enough in their stock quotations.

Affairs had become exacerbated when an equity suit, in which the precise matter at issue was involved, reached the United States circuit court of appeals in New York. On December 1, 1876, one John J. Bate applied for a United States patent for a process of preserving meat during storage and transportation. The patent was granted to him on November 20, 1877. In the interval two foreign patents were also granted to him, which expired before the end of the term of his American patent. Bate sued some butchers in New York for infringement. In defence it was insisted that, although Bate's patent appeared on its face to be still unexpired, nevertheless it had expired by reason of the expiry of the earlier foreign patents, and before the beginning of the suit; and hence that the court was without jurisdiction. The court sustained this plea and dismissed the case. When it came up to the circuit court of appeals, that tribunal turned to the supreme court of the United States for advice, and asked it to decide "whether the invention for which the United States patent aforesaid was issued to said John J. Bate had been 'previously patented in a foreign country' within the meaning of those words in Section 4887 of the Revised Statutes, and whether the patent expired under the terms of said Section before the expiration of the term of 17 years from its date."

The corporations, it is needless to remark, arranged to have this question argued before the supreme court in the most elaborate manner and by the ablest lawyers. Hence the rights of Mr. Bate were represented by an array of distinguished legal talent, headed by the chief counsel of the American Bell Telephone Company, and the rights of the butchers who were alleged to have pirated the refrigerating process were ostensibly defended by another array of legal luminaries equally impressive. Besides these, special telephone interests hostile to the Bell monopoly were permitted to send their representatives to join in the opposition. The briefs and arguments say very little about Bate and his invention, but Section 4887 is discussed to the vanishing point.

It is not necessary here to review the contentions of those who pulled against the stream and against the stalwart strokes of the opposing forces who sedulously backed water and sent the boat along with the flood, as it was inevitably bound to go. The gist of the whole matter and of the supreme court's decision may be stated in a very few words. The corporations, as I have said, wanted the court to read into the statute the words "prior to his application," so that the law would make a foreign patent limit an American one only when granted *before the American patent was applied for.* The court declined to insert, by any judicial construction, those words in the law; for to do so, it said, would be to legislate, and not to interpret the statute.

And so the law remains just as it has always been since it was placed upon the statute-book, with the meaning attached to it which everybody has given, except those who have been interested in reading it in a different way.

The whole effect of this final settlement of the question cannot be safely estimated, because no one knows all of the patents which may be influenced. In New York the existing injunctions under the Edison incandescent lamp-patents have already been dissolved, and this course will undoubtedly be followed in all other parallel instances. The Berliner and early Edison telephone patents cease to be bugbears to telephone inventors.

But certainly a new crop of old questions will now revive, and the patent lawyers are busily furbishing their reminiscences of them in expectation of future frays. For example, since an invention "patented in a foreign country" is the limiting cause, what does "patented" strictly signify? Patented in the sense of United States law, or patented in the sense of foreign law, or merely *prima facie* patented. And if the thing *prima facie* patented turns out never to have been actually and validly patented at all, what becomes of the later United States patent assumedly rendered void by the apparent foreign patent which *ab initio* had no legal existence?

Then there is the accidental suffering argument. The American patent is allowed. The inventor, taking advantage of the 6 months' delay, endeavors to arrange that the American patent shall issue here and a foreign patent be filed abroad on the same day, thus seeking to prevent one patent having any effect on the other. But, through some accident, his nicely-laid plan fails. His letters of advice miscarry ; his money draft is carelessly made out ; snow blocks the railway and the mails are late, or the telegraph wires are down ; a clerk somewhere takes an unexpected holiday ; his cable despatch is confused,—any of these things may put the granting of the foreign patent ahead of that of the American patent, and the mischief is done. *Ergo*, the law is intolerable.

Or, to make matters even worse, there is the doubt as to whether the earlier-granted foreign patent which limits must be that of the American inventor, or may be that of anyone else. The statute contains no words of restriction whereby, in both cases, the patentee is to be one and the same person. Indeed, to insert such words now seems to be as much a legislative act as that of adding the other words which the supreme court refused to read into it. If this be true, woe betide the inventor who incautiously reveals the subject of his American application ! There is nothing to prevent his enemy or competitor, learning thereof, from obtaining immediately an Italian patent which will terminate in 1 year, and thus the unfortunate applicant in the United States, who may be delayed in the patent office by its endless red-tape for more than 12 months, may find his American patent dead, killed by his enemy's earlier Italian patent before he ever gets it from the patent office.

So the American patentee, until congress shall relent and come to his relief, is left by the supreme court " between the devil and the deep sea." If he has his American patent granted first, and it gets over to Germany or England, for example, his patents in those countries, subsequently sought, will fall because of the so-called prior introduction of knowledge into the realm. If he has his foreign patents granted first, he may seriously reduce the term of his American patent. Of course, there are ways of managing these things by dint of prudent foresight, quick and astute correspondents, and the Atlantic cables, so that the risks are reduced ; and, in reality, the dangers to an inventor who keeps his secrets and applies for his foreign patents at the proper time and in the proper manner are much less formidable than they appear.

It is perfectly true that congress is omnipotent in these matters, and can impose any conditions or terms upon the inventor which it sees fit as a condition precedent to giving him his patent ; but the whole spirit and sense of our patent system favors the utmost liberality and consideration to the inventive genius of the nation, and is sternly against hampering or harassing it in any way. For this reason every attempt to impose recurring taxes upon patentees, or to compel them to "work" their devices, under penalty of forfeiture of patent, after the fashion of many foreign countries, has failed; and even the perennial grab of the Western Granger at the four-million-dollar surplus now to the credit of the patent office in the United States treasury, for school purposes and other improper diversions of it, regularly comes to naught.

There can be little doubt that Section 4887 does not serve any beneficial purpose, if it is not altogether mischievous in its effect. Public opinion is, and, for a long time, has been, in favor of the elimination of the limiting provision in it; but the obstacle to congressional action has chiefly been the strong prejudice against the corporate monopolies, the desire to curtail their privileges wherever practicable, and the consequent unwillingness to enact a new statute or amendment which should be retroactive, and hence amount to a virtual extension or rehabilitation of their patents, otherwise defunct. Now that the supreme court has spoken, congress may regard the subject in a different light, and relieve future patentees of the objectionable conditions which the statute imposes.

There is, of course, a natural and widespread demand for a list of the patents which have been terminated by this Bate decision, and for information as to just how and wherein important patents have been affected. But to prepare a complete register of all the American patents which have been destroyed or limited by the decision would be an absolutely impossible task, and for manifest reasons. There are no patents nowadays which are generally known by everyone as foundation patents; or, to put it another way, an industry may be founded on scores of patents, each for a detail. The owners of these naturally keep the fact of their limitation by prior foreign patents exceedingly quiet; and such circumstance never does come out in the natural course of things, except in the course of a litigation.

True, the fact whether or not any particular patent has been restricted by the statute is shown at once by the limitation which the patent office writes on the face of the grant, if the applicant formally acknowledges his prior foreign patent in his American application. Frequently, however, he does not make such acknowledgment, because the foreign patent may not have been actually granted at the time he files his American application. If, however, it becomes granted during the pendency of the latter, and the patent office discovers the circumstance, it usually compels acknowledgment. The discovery is often not made.

Or the American applicant, in his foreign patent, may have mixed up the subject-matter of his American application with other inventions, or presented it in different guise, or as adapted to a different purpose ; and in this way, having convinced himself that his foreign patent is not for the same invention as that sought in the United States, he of course makes no acknowledgment of the former. The patent office rarely ventures to disentangle this snarl. To do so regularly would require a great addition to its present inadequate working-force and miserably insufficient facilities for research. It usually contents itself with unearthing earlier foreign patents which are unquestionably for the same invention, and sometimes wrangling over whether the foreign patentee—if of different name from the American applicant—was or was not in fact acting as the agent or with the constructive consent of the latter. At the present time it is somewhat uncertain over the question before noted as to the limitation of an American patentee's rights by an earlier foreign patent when granted to somebody else ; but, on the whole, it seems to incline to the negative conclusion.

Where no such limitation actually appears on the American patent, the existence of a prior foreign patent can sometimes be found by a search through the files of the foreign patents which are available at the Astor Library in New York, the Public Library in Boston, the Patent Library Office in Washington, and several other places. But, as all foreign patents are not published in printed volumes, such a search is far from conclusive of the non-existence of a limiting foreign grant ; and, in any event, it is a task involving special knowledge of the technicalities of patent law and always calling for skilled professional assistance.

THE PROPOSAL TO LICENSE ARCHITECTS.

By John Beverley Robinson.

SOME forty years ago, while New York was still a small town; when the Forty-second street reservoir and the Crystal Palace, its neighbor, were far out in the fields; when Genin, the hatter, was the Dunlap of his day,—there was a fire in Broadway, near Prince street. As the firemen worked to overcome the flames, a catastrophe occurred; the beams of several stories, released by some unknown cause, fell together, killing several persons. Afterward it was found that the ends of the beams had rested on a four-inch brick wall, built up against an adjoining wall. There was general indignation at so inadequate a construction, and forthwith, as promptly as could be desired, "a law was passed" forbidding that particular fault in construction. Thenceforward, year by year, decade by decade, grew the volume of the laws regulating building,—from a paragraph to a pamphlet, from a pamphlet to a volume; still buildings continued to collapse with undiminished frequency and fatality. The business of seeing that the law was carried out was taken from the fire department, of which it had been a function, and was made an institution by itself, with a head, or at least a chief, a deputy-chief, and half a hundred understrappers.

Still buildings persisted in falling, until the latest crash—the Orchard street disaster—has caused a movement for the same old remedy,—further legislation.

As the dyspeptic earnestly desires more pie, in spite of his experience that it will not give the expected gratification; as the ancient farmer, having made himself an invalid with pill-dosing, thinks only of more, and more various, "physic" as an alleviant; as the Feejee islander renews his dances and sacrifices, after his hut has been blown away by the tornado, to prevent, if possible, the malign deity who has caused such destruction from repeating it,—so the mass of men, notwithstanding the continued demonstration of the inefficiency of law to produce the desired results, cheerfully, and with child-like faith, keep on, enacting new laws after each failure of previously-existing laws to do what it was hoped they would.

At this moment there is before the Albany politicians a measure which, by their sovereign power, they are urged to force upon the people, forbidding anybody to pursue the business of designing buildings without a license which a group of five men is to have virtually absolute power to grant or withhold. Such a measure, if passed,—and it is altogether probable that it will pass, since in the wilderness the only voice that I hear in protest is my own,—will be thoroughly retrogressive, a step backward, undemocratic, un-American, tyrannical.

Set down, in the first place, the entire inefficiency that I have been talking about.

A building totters and goes down, and we enact a law; down goes another, and we enact more laws; a row of houses tumbles, and we get mad and enact four or five more laws and imprison a Buddensiek or two, and feel that we have guarded against such accidents in future. As we rest happy in our unjustifiable conclusion, a Park place horror comes, and, instead of looking for some more effectual preventive, we go back with undiminished fervor to our old resort of making more laws. On top of it all comes this Orchard street smash, where, though everything seems to have been done according to law, the building falls in utter ruin and several persons are killed.

Can nothing persuade us that the causes are deeper than law can remove?

Is it not possible to force upon our understandings that an engine that has so often failed to work as we wanted might as well be cast aside, and relief looked for elsewhere? Are we bent upon continually taking the turning that always brings us around to the point whence we started?

If it were that architects in general were known to be inefficient and incompetent, the measure might seem to be not so unreasonable. Is it true, though, that architects have shown themselves devoid of skill, intelligence, prudence? Have they not, on the contrary, at all times, and very conspicuously of late, shown themselves most able?

Have they not originated and developed an entirely new thing in construction, the steel frame building clothed with masonry and carried to an unheard-of height,—something which, if not involving any new principle, involves such radically new methods of using materials as to deserve as much honor; and have they not done this without a single overturn?

Are such men to be distrusted, hampered, regulated, tied up with red tape, forbidden to do their work without the permission of a select five who have demonstrated only their own skill in getting appointments for themselves?

On the other hand, are not buildings done by legal, governmental methods, with requisitions, and bids, and safeguards of all sorts, the most notable failures?

Were not the United States Building and the Illinois State Building at the Chicago World's Fair notoriously the worst designed there?

Is not the great public building in Chicago in a state of chronic collapse?

And where constructive stability is attained by governmental methods, is it not at an absurd and ruinous expenditure, as in the ugly and infamously extravagant Albany Capitol?

The profession at large has shown itself as worthy of the freedom it enjoys; as failing where hampered by restrictions.

The only deficiency has been perhaps among men hired at a cheap rate by speculative builders to "drore out" rows of tenements of conventional type, whom the speculative builder himself would never have trusted were he not confident that the building department, whose business it is to protect the dear public, would see that everything was right.

Strange to say, the bill now up expressly provides that this class of designers shall not be restricted. "Nothing herein contained," says Section 14, "shall be construed to prohibit any person . . . from acting . . . . as designer for any person employing him, with full knowledge on the part of such employer that the person so employed is not a licensed architect," thus assuring exemption from pains and penalties to the most unscrupulous cheap builder who chooses to hire the most incompetent cheap draughtsman.

I have always wondered that architects in general were so lost in admiration of a building law that tended to detract so much from the esteem their experience deserved by exposing them to the competition of the greenest hands, whose errors their clients thought were guarded against by the existence of the law. It might well have been entitled, "An act to help out the ignorant and enable them to practise architecture, and to diminish the emoluments of ability."

The inefficiency of the license system, or of any system of hampering free competition by legal restriction, is seen in other occupations where it prevails.

Take medicine, for instance: the time was when everybody thought that the doctor was a semi-supernatural being. Blue mass and black potion were swallowed with exemplary faith in their effects; without such prescriptions the patient would scorn the practitioner.

But now matters have changed; only the lower classes accept medical treatment blindly. The educated must understand the general meaning of the proposed treatment; will take nothing blindly; are strongly disposed to doubt the potency of medicine anyway, but at the worst do not doubt it as much as the faculty themselves. Both doctor and patient, however,—I speak still of educated patients, – look with equal distrust upon the raw graduate of the schools.

So, too, in law,—the closest guild that there is. What does a legal diploma amount to? A good deal, no doubt, as assuring one a share in the proceeds that a monopoly may expect to acquire, but nothing at all to conciliate the confidence of an evasive client.

The often alleged and plausible reason for restrictive laws—the desire to protect the public; at first blush an eminently reasonable and laudable desire—on examination quite dissolves; the restriction proves to be rather a means for deluding the public into a false safety, filling them with the idea that a diploma-bearing individual is really competent. The only true protection that the public needs is intelligence in its choice of architects, or doctors, or lawyers, and full responsibility for a failure to use its brains successfully.

Liberty and responsibility develop intelligence; paternalism retards its growth.

Supposing, however, that the restrictions proposed could be shown to have power to produce the desired result, how is it possible for the most ideally perfect regulations to succeed, when committed into the hands into which they must be committed?

Into the hands, I mean, of politicians.

We have recently obtained some interesting information as to the inner workings of politics and of political appointees. True, we have before obtained glimpses of what went on. Long time ago our old friend Bill Tweed and his henchmen were shown up by a newspaper, probably because they refused to divide with it. Later came the celebrated Boodle Aldermen; and in other places there have been discovered boodle aldermen and boodle other men. Recently the most astonishing revelation of all has burst upon us. Rotten through and through, root and trunk, branch and leaf, we have found the political world, and we have set about "reforming" it in dead earnest, perhaps a little dashed by the promptness with which reformers become politicians and the extreme hesitation—to put it as suavely as possible—of politicians to become reformers.

Yet into such hands we propose now to commit the absolute power to suppress any member of an honorable and noble profession. Most astounding of all, the movement is fathered by that profession itself!

Oh, no! you reply, we have no intention of giving any power at all to politicians; our mind is to summon the ablest and wisest of the profession itself, and to let them have the job.

However able and wise architects there may be, it is not the ability to build well that will command the appointment on the State board; it is the ability to get appointed that will determine the matter. And the making a business of getting a place and keeping it is what constitutes a politician, whether the place be directly in service of a government or indirectly in service on a board of governmental appointment.

For, after all, this precious "State board" will depend for existence upon legislation, and upon its power to influence legislation, and, if that does not make it a political appointment and its members politicians, I do not know what could.

Conceive then the law passed, the board appointed, the whole scheme grinding away merrily. Add, if you please, that it works smoothly enough, that nothing but the recognized methods of influence are used,—acquaintance, friendship, do me a good turn and I'll do you one,—and that the secret, unadmitted methods as yet have not come into vogue. What is the result?

Inevitably the supplanting of the fervor and energy of free men by the cut-and-dried formulas of a close corporation. Gradually the influence of the board itself will make itself known in the appointment of successors. Slowly the particular style of architect admired by the members of the board will crystallize.

Eventually the life will be beaten out of it, and American architecture—the only living architecture—will lie a corpse, alongside the corpses of European architecture, in the Bluebeard chamber of governmental suppression.

I do not mean to deny that American architecture is crude, half-barbarous, unworthy of comparison with that of older countries: but I do say that its crudity is due to the fact that we, as a nation, are crude; that, in spite of its brutalities, it still has life and growth, and is not a mere appeal to precedents, as is the case in European countries,—a fact bewailed by European architects themselves.

Restriction means stagnation.

Let us leave the comparatively trivial objections that I have been urging, and dwell for a moment on more important questionings.

What is this right, so arrogantly claimed, of forbidding others to work at whatever they please; to call themselves by whatever descriptive title they may prefer? Are these people at Albany, in their lucid intervals, justified in voting anything they choose? Is the majority of the people, which they at Albany, are, by a legal fiction, supposed to represent, justified in enforcing any conceivable enactment upon the minority? If not, where is the limit?

Why should they not continue their wise measures, and require licenses for builders as well as for architects? Far more serious than—no, hardly that, but quite as serious as—the blunders of an architect might the blunders of a builder be.

Or let them restrict electric-light fitters, and electric-appliance makers, filled with possible danger from ignorance, both of them. Or let them go on and restrict grocers, and butchers, and bakers,—restrict everybody, require a permit for existence, Russian-fashion, in the form of a passport! Ah, no, that would be tyrannical. Why that, and not this?

The truth is that, although a majority has the physical power to do anything it pleases, it is quite opposed to the theory of free popular government that a majority should exercise that power. "Oh! it is excellent to have a giant's might, but it is tyrannous to use it like a giant."

In a free government the majority is supposed to recognize the principle that it is not wise to use its power to the full; chiefly for the reason that, when it in turn becomes a minority, the machinery of tyranny that it has created will be used against it.

Therefore the majority from time to time, in Magna Chartas and Independence Declarations, promulgates the limits that are to be placed to the exercise of power, summed up in the statement that it is not wise to use power for anything but the defence of liberty.

Picture to yourself a man who has been practising as an architect for many years. He has won the confidence of many friends who testify of his skill to others.

He neglects to obtain, file, and pay for the registration of a license. He is arrested, hauled away, imprisoned, tried, and from fifty to five hundred dollars of his earnings taken by force from him. For what? What has he done? Whose liberty has he limited?

I am well aware that the present proposition is quite in line with what has been done in the past: the more reason now for speaking out.

It is true that the tyranny of the majority is daily intensifying; that the unjustifiable restrictions of medicine and law are added to by the recent restrictions of plumbers,—which, by the way, have stopped progress in plumbing in New York; that we fine poor men for trying to make a living by selling shoestrings; that there are a dozen other vocations similarly hampered, capped by the newest scheme for the licensing of chiropodists!

Yet we are such slaves in spirit, and tyrants as well,—for the submissive nature always complements that of domination,—that we do not even think, or know, or care, that our liberty is infringed.

For my own part, I repudiate it all. I do not regard any of the gentlemen at Albany as representing me. I do not acquiesce in anything and everything that they authorize. Their alleged right to govern lacks, in my case, the consent of the governed. Whatever they do, as far as I am concerned, they do by brute force, without moral right, including the tribute they exact from me.

If the majority does not recognize this reasonable limitation of its actions to the defence of liberty, a democracy becomes an intolerable despotism,—worse than that of any monarch, for a despotic monarch may chance to possess liberal individual tastes, but a despotic majority is, like a corporation, without a conscience.

But I would not be understood as underestimating the astuteness of the gentlemen who have fathered and are fostering this particular measure to license architects. They know, the more perspicacious of them, well enough what they are about. The measure is really intended to restrict the number of accessions to the ranks of a profession which have of late been filling up rapidly. The competition of new men, especially of the incompetent, who are enabled to compete by grace of the building inspector's looking out for them, is becoming a serious matter. Other people get privileges from the representatives of the people ; in fact, the chief occupation of the representatives is granting privileges. And the undeveloped crowd has so much admiration for a title and a diploma; almost as much as for that incontestable evidence of a pull,—a free pass. Therefore, as privilege breeds monopoly, and monopoly for some breeds scarcity for others, and scarcity of work reduces the amount to divide, why not add another privilege to the many that exist and check this fatal competition !

That is the true motive, and an eminently intelligible and rational motive it is ; it has my unfeigned admiration.

Only I should be glad if the public, the dear public, were a little less fond of being protected by kind people who volunteer to protect it, and a little more fond of protecting itself. I think that all the members of the public, including myself, would be happier if they cared more for real protection against privilege than they now respect the false protection which involves tyrannical suppression of liberty, and is sure to eventuate in the creation of continually new privileges in unending complication.

I am well aware that protest at this moment is probably vain. We teach our children to perform adoring evolutions before flags which are held to symbolize freedom ; we inculcate various phrases and songs implying a preference for freedom ; but such external demonstrations tend to destroy and supplant the quiet inward knowledge of what liberty really is, which, when acquired, has no taste for announcing itself by such superficial and thoughtless enthusiasm.

The knowledge of true liberty, such as Thomas Jefferson and the rest of the coronal stars of liberty-lovers once promulgated, and for which the fathers fought, is rare ; those who have it speak it not above their breath ; every day our liberty is more and more encroached upon.

Yet no doubt the tide will some day turn, and new prophets will again proclaim liberty and all that it means to a people who will then maintain it better, because they will understand it better.

HOW HOLLAND WAS MADE.

By Foster Crowell.

THE Dutch, we are told, gaze complacently at their marvellous country and say: "God made the sea, but we made the land;" and they are right, both in the fact and in their pride therein, for there is no other fatherland in the world that has been wrested from the sea, and no recorded work of man has been at once so bold, so vigorous, so intelligent, and so practical as the gigantic task which their far-away ancestors conceived, which their forefathers carried on with triumphant success, and which they themselves are to-day prosecuting on a more stupendous scale than ever. Away back, before the beginning of the Christian era, when the Roman conquerors came, or even before that, began the task that still enlists, after nineteen centuries of toil, the best efforts of an enlightened nation.

Where a brave and determined people struggle and stand in a common cause, as have all the Hollanders in this grand achievement, it is surely not right to attribute the success to any one class of workers; yet I think my professional brethren of the Netherlands may feel an extra pride in the results, for the reason that the efficacy of the work depended, and still depends, first of all upon the engineer, but for whom, probably, there would now be no Holland.

We shall see presently what part the engineer played, and how early in the dawn of civilization in Europe he appeared. But this, after all, is a side issue; we are now concerned chiefly with what was done, and, in order to understand it rightly as a process we must first turn our attention to a thing that probably does not exist outside of Holland, —a *Polder*. Polder is a Dutch word, which has no equivalent; at an earlier period it meant a lake, or pond, or bog, without natural drainage, the bottom being below sea-level; now it is used to designate a lake that has been drained dry, artificially, after being encircled by levees or dikes for protection against water from without and control of the water within. The word has attained in modern days a further and more exact significance, meaning an area of agricultural land of recognized boundaries, divided into separate (generally small) lots and ownerships, surrounded by dike protection, and requiring to be continually maintained in a state of efficient drainage by artificial means; it may or may not have been reclaimed directly from the sea. In other words, it has come to have a territorial significance. Those who have read Beekman's "Nederland als Polderland" need not be reminded of the vital necessity of the polders to the Holland of to-day.

"THE WATER MILL."

From Hobbema's Celebrated 17th Century Painting in the Amsterdam Museum.

IN AMSTERDAM. THE OLD "WAAG" OR WEIGHING HOUSE.

ZAANDAM POLDER.

RUYSDAEL'S "THE WINDMILL."

From the Painting in the Amsterdam Museum.

In his address of welcome* at the Inland Navigation Congress at the Hague last summer the president of the reception committee, Mr. J. F. W. Conrad, formerly inspector-general of the *Waterstaat* and a very high authority, gave a most interesting and instructive account of the polder region and its conservation, from which I have translated brief extracts for the present purpose: it was illustrated by a number of expressly-prepared maps and cuts, some of which are here reproduced.

(It may be of interest to state that these International Congresses are held in some one of the participating countries every two years; the fifth was held at Paris in 1892, the seventh is to be held at Rome in 1896. The sixth was participated in by 115 government delegates from 16 countries,—*viz.*, Netherlands, United States, Great Britain, Germany, Austria, Belgium, France, Hungary, Italy, Norway, Sweden, Portugal, Roumania, Russia, Siam, and Switzerland; also by 278 delegates of 27 Dutch societies and 162 foreign societies, and by 1048 subscribers, of whom 202 were from the United States.)

"In the course of excursions in the Netherlands," said Mr. Conrad,

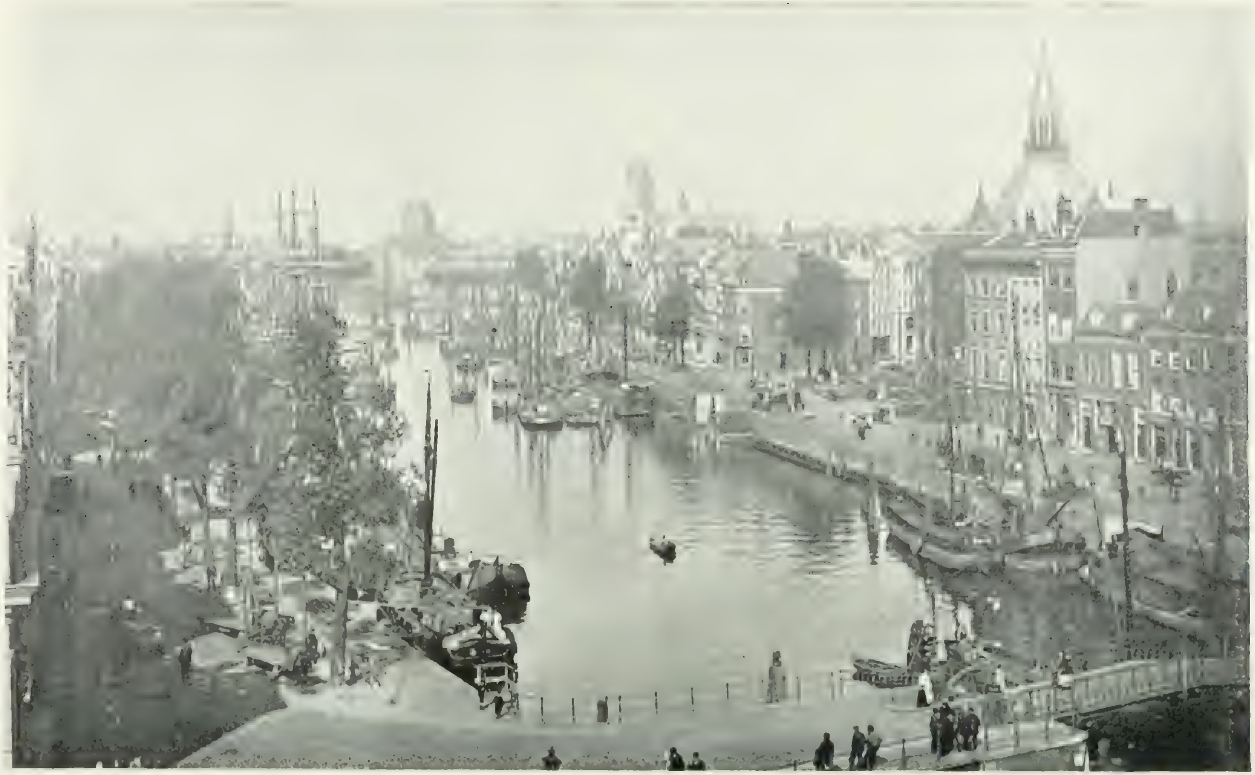
---

*Compte-rendu des Travaux du Sixième Congrès International de Navigation Intérieure, La Haye, 1894, pp. 18–33.

"you will see the rivers, canals, and ports; the railways and the common roads; the dunes and the dikes along the sea-shore; and, in the vicinity of the polders, locks, windmills, chimneys of steam engines, embankments, and drainage systems. You will note that in those regions the occupied and cultivated ground is several meters below the level of the sea, or of the adjoining river or canal, the latter usually a navigable way, bearing thousands of sailing vessels and steamboats, engaged in commerce and industry. This complicated condition, which will very forcibly attract your attention, is the result of the circumstances to which the soil of Holland owes existence; a soil which, to be rendered habitable and tillable, must be artificially defended and protected against the threatening waves of the North Sea, the scour of the rivers, and the grinding of the ice, while at the same time it must be relieved of surface-water and infiltrations by discharge into the rivers, or into the ocean, which generally must be effected artificially, —at least, in the polder region. This situation has been produced in the course of centuries by the combined effects of nature and human industry."

With this picture, and the maps, before us, we will proceed to freely avail ourselves of Mr. Conrad's facts and figures without further quotation marks. About 59 per cent. of Holland is alluvial. The curved line extending from southwest to northeast on Map No. 1 in-

A NAVIGABLE WAY.



THE LEUVENHAVEN OF ROTTERDAM.

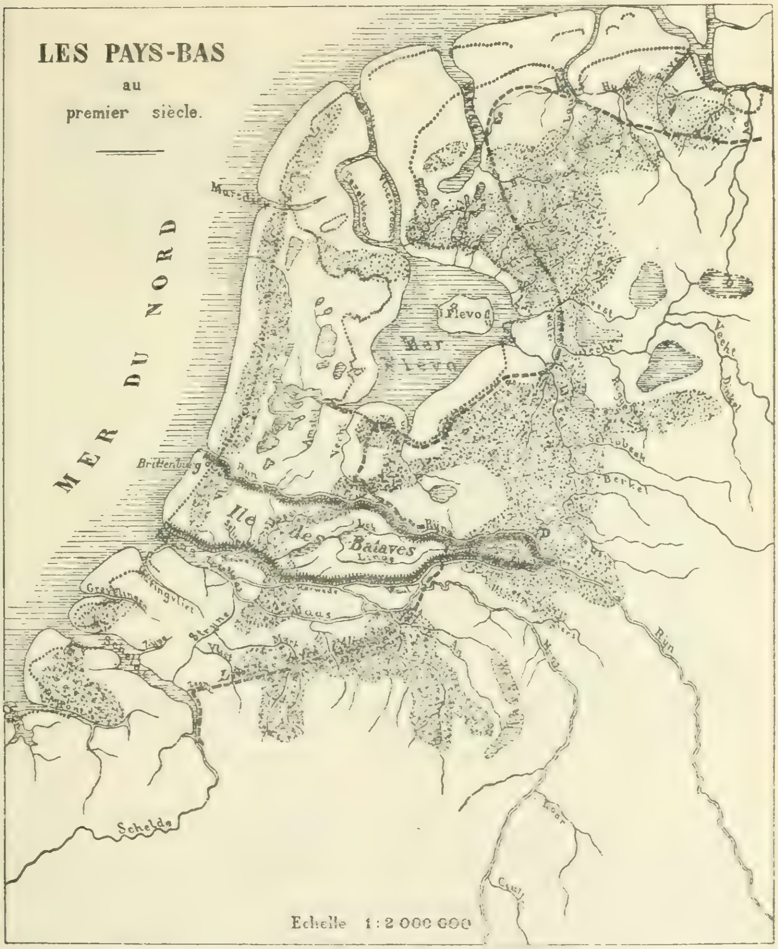
CANAL VIEW IN DORT.

IN UTRECHT. THE OUDE GRACHT.

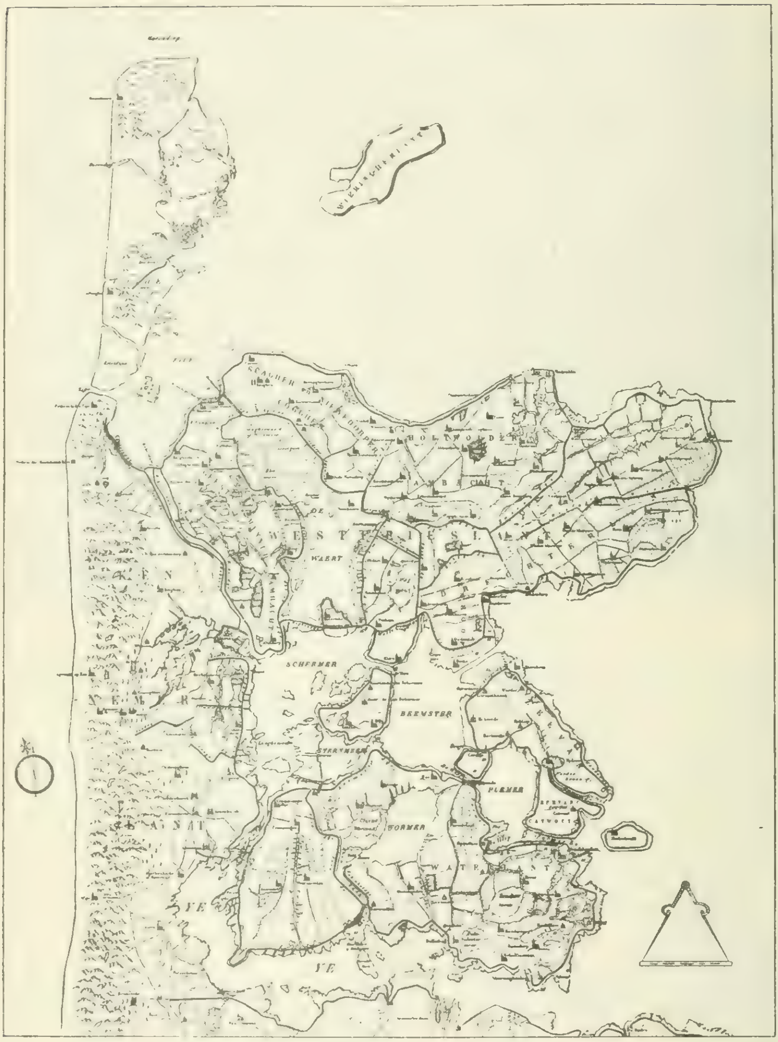
dicates approximately the western limit of the diluvial upland; the alluvial part contains 7500 sq. miles, which is about the size of New Jersey. Geology tells us that at the end of the diluvial period all the western part of the low countries was a shallow, interior, sand-bottomed lake, separated from the North Sea by a chain of sand dunes, into which flowed the rivers Rhine, Meuse, Vecht, and Yssel; in course of time, the bottom of the lake became covered with deposits of marl and clay, and these in turn with peat-beds 10 to 15 ft. thick, formed from water-plants and the *débris* washed down from the upland forests. The peat-beds extended over the entire area at present occupied by North and South Holland, and parts of Frisia, Groningue, and Over Yssel. Great forests grew upon them, and at length became peopled with Germanic tribes,—the Batavians of the Roman chronicles.

The Roman general, Claudius Drusus, who waged war upon the Batavians, built a dike along the left bank of the central arm of the Rhine, and his successor, Paulinus Pompey, continued it to the North Sea near Katwijk: this dike—the first to be built in the Netherlands—is shown by the fringed line on Map No. 1, which has been compiled by the eminent geographer, Kuyper, to give a general idea of the low countries in the first century, when what is now the northern part of the Zuyder Zee was a peat-bog covered with slimly-inhabited forests, while the southern was a large fresh-water lake, called by the Romans Lake Flevo and in the middle ages Lake Almeri. The peat was excellent fuel, and the excavations made to obtain it by the early inhabitants formed the first step in the transformation of these lowlands into numerous ponds, large and small, united by the water courses of the swamps.

Claudius Drusus not only built the first dike, but cut the first canal, through which his son Germanicus, according to Tacitus, conveyed his army on rafts of timber felled on the island of Batavia ; it



MAP NO. I.—THE LOW COUNTRIES IN THE 1ST CENTURY.



MAP NO. 2.—NORTH HOLLAND IN 1288.

united the Rhine with the Yssel, and was known as the *Drusus gracht;* it is indicated on our map by the letter D.

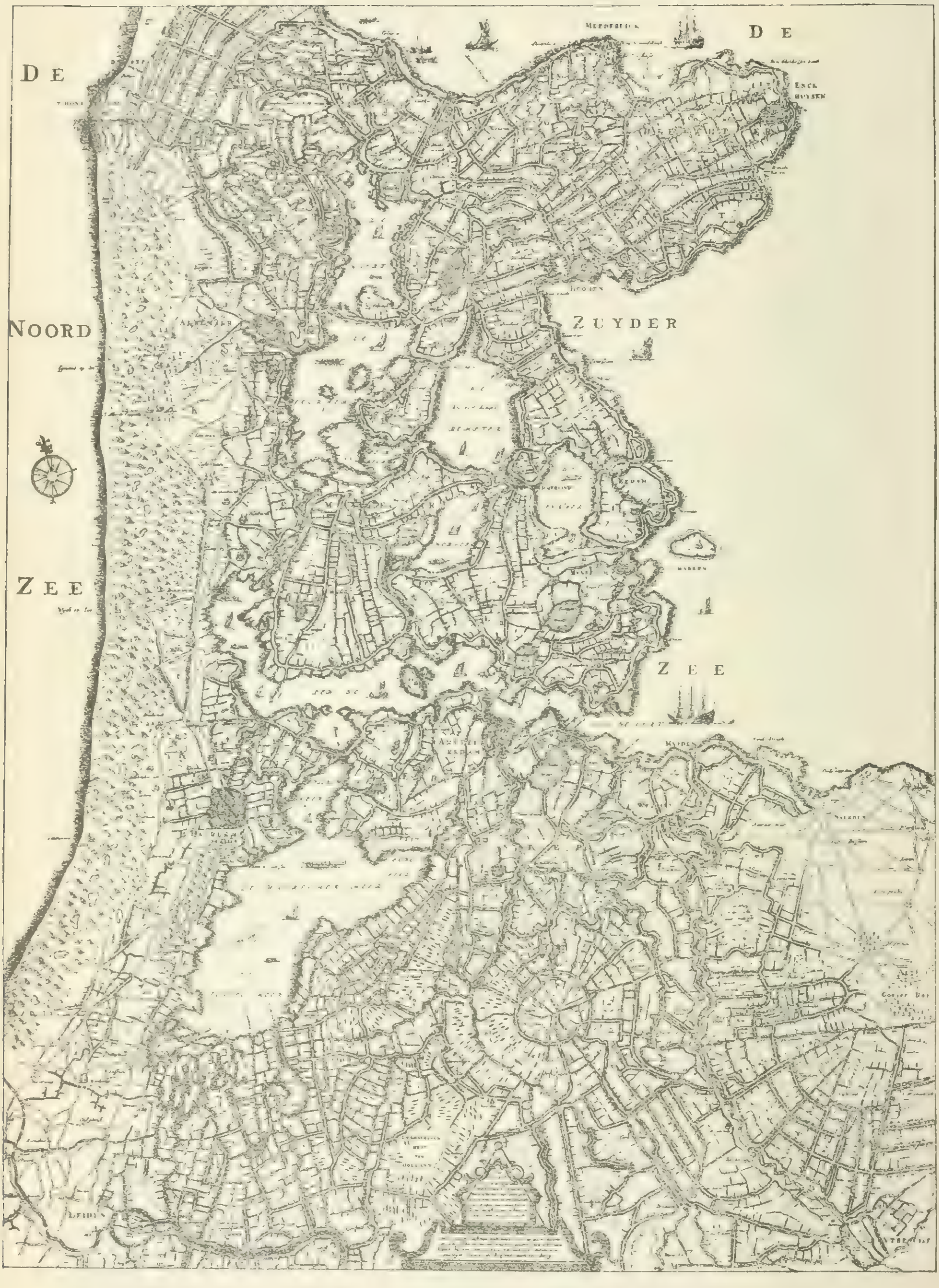
Inundations during the seventh, eighth, and ninth centuries, and especially those of 1170, 1230, and 1237, continually and greatly enlarged the communication between lake and ocean, and so the destructive effect of the incoming tides became greater and greater; the soft peat formation was undermined, and the surface sank or was swept away. By the year 1395, 1500 sq. miles had thus been swallowed by the sea, which means that all the firm ground, excepting the fringe of islands of North Holland and Frisia as at present, had disappeared from the northern part of the Zuyder Zee, which had become one with Lake Flevo. That was the culmination of the destruction.

To fully narrate how this vast watery waste was transformed into a fertile country studded with fair cities would fill many books: in this brief paper we can only touch upon the most striking features, confining ourselves to one typical part of the country, the province of North Holland, in which the peat workings had become, by 1221, very valuable and extensive, while the wave-action and the freshets were ceaselessly widening the channels and extending the ponds.

North Holland of 1288 is shown on Map No. 2, which has been reconstructed by State Counsellor Doctor G. de Vries. The earliest geometrically-projected Dutch maps which possess any considerable degree of exactitude are those of Jacob Roelofszoon van Deventer, showing Holland south of the Y in 1542, and of Jacob Janzoon Beeldsnyder, who, by order of the Duke of Alba, plotted in 1573–75 a chart of North and South Holland between the sea-dike of West Frisia and the branch of the Rhine known as the Leyde. This last was printed in 1610, and is reproduced here, very considerably reduced, as Map No. 3; with other data from ancient records, it served as a basis of the 1288 map.

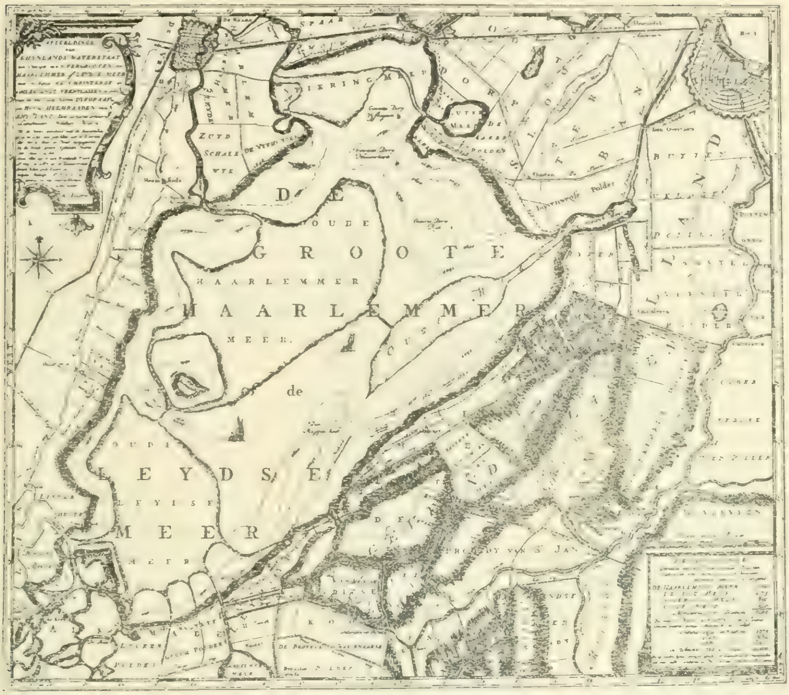
Northern Holland in 1288, as we see then, was composed mostly of sheets of water, formed partly by natural causes and partly by the peat workings, and which, as far as the lakes of Schermer, Beemster, Purmer, Stammer, the lakes west of Alkmaar, and Langemeer (see Map No. 2), communicated with one another and the Zuyder Zee, so that it was possible at that time to go by boat from Amsterdam westward to the Gulf of Y, thence through the North Holland lakes, and return to the starting-point by way of the Zuyder Zee, without encountering a single impediment in the shape of dike or lock. A great part of North Holland was thus directly exposed to the inroads of the sea, and there were besides, outside the limits named, other large peat lakes, of which the Waert and those lying north of Wormer were the most important.

After the destruction of the country in the northern part of the Zuyder Zee, the sea-tides came to have much greater effect, and the dikes and *kaden* which had been built by the people around their dwellings either succumbed or were in constant peril. To remedy this dangerous situation three openings were closed by dikes: first that of Etershem, by establishing the Schar-dam some time between 1311 and



MAP NO. 3.—HOLLAND IN 1575.

Reproduced from Beeldsnyder's Original Chart drawn for the Duke of Alba.



MAP NO. 4.—SHOWING SUCCESSIVE STAGES OF HAARLEM LAKE, IN 1531, 1591, 1610, 1647, 1687, 1740, AND 1848.

1319; next the Crommenye, by the Niewen-dam in 1357; and then Purmer Ee, by the Monnicken-dam in 1400. The river de Zaan had been diked previously to 1288,—probably because of the historic high-tide of 1237. We thus have North Holland as represented on Beeldsnyder's chart; it will be noticed that the changes between 1288 and 1575 were relatively insignificant. One is tempted to follow this interesting lead, but can pause only long enough to see what the famous Haarlem Lake of our times consisted of in 1575; for which purpose we will cast another glance at Map No. 3, and also at a special reproduction—Map No. 4—of the comparative conditions at intervals from 1531 to 1848, the date of its final drainage. This shows that during the 300 years covered by the map the superficial area of the four lakes of Spiering, Haarlem, Leide, and Old lake (which first were either separated by dikes, or connected only by very small streams, and became merged in one called the Haarlem-mer meer in 1591) increased from 5600 to 16,850 hectares (65 sq. miles), or almost exactly three times.

There is no indication that until near the ending of the sixteenth century the good burghers of Holland felt the need of any more fields and pastures than their slender share of dry land afforded; if they did, it is probable that money was lacking and the technical means were not understood sufficiently well to warrant an attempt to dike and drain the lakes whose soil was so excellent.

Nevertheless, the three essential contrivances were already known and applied,—namely, canal locks, mills for raising water, and, of course, dikes. Locks consisting of two gates and an intermediate chamber, such as are in use to-day and which are generally termed lift-locks, have commonly been ascribed to Leonardo da Vinci. It is very interesting to hear from such a high authority as Mr. Conrad on this point, and, in order that there may be no misunderstanding, I quote him as closely as translation permits.

"There can be no doubt whatever that lift-locks are of Dutch origin, and were first established in Holland. It has been claimed by some that the pass at the Sparen-dam cited in the charters of Count William II, King of Rome, dated April 9, 1253, and October 5, 1255, and indicated in the original Latin text by 'Spoya,' was a lock, either with sliding gates or with a chamber, of simple construction, but capable of taking vessels with cargoes from the Y to the Spaarne, and also in the opposite direction, through the dike established about 1250 at Spaarndam. Although this allegation does not rest upon a very exact basis, it is nevertheless true that Count William III, in a charter dated 1315, confirms the lock rights (*droits d'écluse*) at Spaarndam, while a letter written concerning Holland in 1413 by the Count of Hainant makes mention of locks (*écluses à vanne ou à sas*) near Amsterdam. The locks at Vreeswyk in the famous Lek dike were constructed in 1435. From the above facts I claim to have proved my point and that I may be allowed to observe that the following statement of M. DeBauve, Ingénieur des Ponts et Chaussées, on page 220 of his Manuel, Paris, 1878, is not exact,—to wit, 'the invention of lift locks (*écluses à sas*) is generally attributed to Leonardo da Vinci and not earlier than 1460, but M. Lombardini has proved that the first lock of that kind was built by Philippe Visconti in 1439 to facilitate the transportation of marble for the Milan Cathedral; it was near Milan, and overcame a fall of 3 meters (9 or 10 ft.) between Laghetto Vecchia and Laghetto Nuove.'"

Wind-mills applied to the displacement of water have existed in the Netherlands for centuries, and are a Dutch invention. In a note by a certain Philip Van Dorp in 1408 mention is first made of "water mills." It is very probable that they were used in draining Lake Limmer and Lake Nesch in 1430, and it is certain that they were used at Schoonhoven in 1452. After the latter date they are frequently

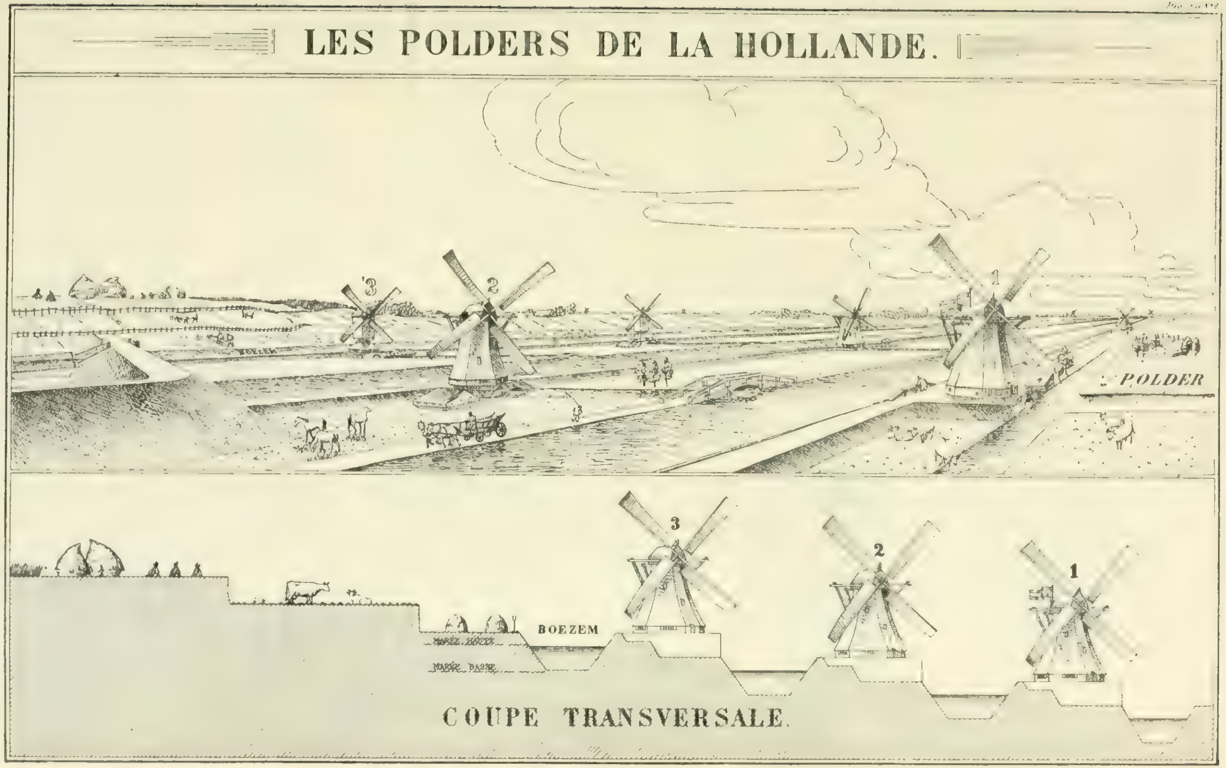
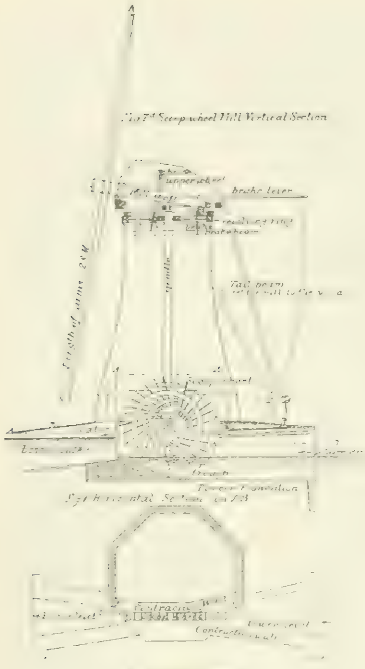


PLATE 5.—A TYPICAL POLDER OF THE 17TH CENTURY.



A SCOOP MILL.

From Beekman's Nederland als Polderland.

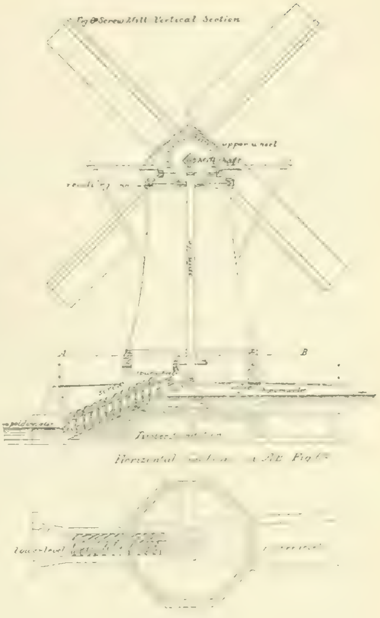
mentioned; their construction and management, at first very crude and primitive, were very soon greatly improved, and the evolution has continued to the present day.

Already, then, in the fifteenth and sixteenth centuries a few small lakes had been drained by windmills, and even Zype, with an area of about 26 sq. miles, had been so treated in 1597; but the great drainage period began with the seventeenth century, resulting from the return of prosperity and the revival of the spirit of enterprise, coupled with the fact that considerable capital was available for agriculture, cattle-raising, and manufactures. In the 28 years ending with 1635 thirteen large lakes, aggregating 92 sq. miles, were diked and drained by windmills, not counting many small ones. "The Dutch had taken Holland." Although, since the advent of steam, it has become possible to carry out similar operations on a much more extended scale, the work of the seventeenth century was typical and complete; in fact, taking into consideration all the attending circumstances, it was even grander in conception and execution than the majestic modern achievements.

We must pass over the difficulties and disasters which the courageous engineers overcame: that they were many and great, and often unprecedented, there is no doubt. Each lake had first to be girdled with a water-tight ring-dike: practicable and efficient water-mills had to be properly located and built; and artificial channels for evacuating the water had to be prepared in advance. The level, as we should say, into which the water was evacuated was called a *boesem*, and the various channels constituted a net-work of canals which served for navigation, and which was in turn separated from the sea or from a river by a strong dike protecting all the drained country. These outer dikes were provided with locks for navigation and also for discharging the superfluous water of the *boesem*. The great Schellingwoude dike has five locks, some large enough for ocean steamers. Often provision had also to be made for supplying water to the polder in dry seasons.

In polders close to the sea—as, for instance, on the island of Walcheren—the inner waters were discharged into them without the intervention of either a *boesem* or an outer dike; but in such cases there were usually interior walls or *kaden* subdividing the polder for greater security, just as a ship's hold is divided into compartments.

In course of time most of the natural water-courses, including some of the greater rivers, were dammed, sometimes at several different points and elevations, so as to be incorporated into the canal system, and so gradually was produced the Holland of to-day.

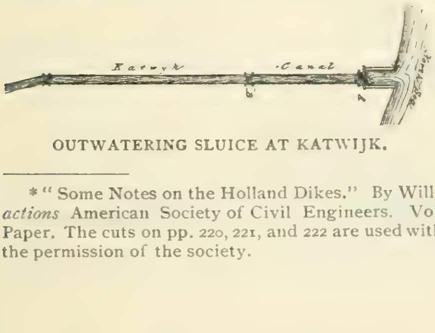


A SCREW MILL.

From Beekman's Nederland als Polderland.

It is to be noted that there are four distinct classes of dikes with separate functions; (*a*) the inner or ring-dikes, as impervious as possible, but not usually requiring great strength; (*b*) the river dikes, or quays, requiring strong protection against ice and floods; (*c*) river dams proper,—important protected structures with navigation locks and sluices; (*d*) the sea dikes, exposed to violent storms and wave action, with locks for navigation and discharge. Frequently also the sand dunes required to be artificially augmented, or treated as dikes. The varieties of structural features and conditions are so multifarious that an attempt to describe them here would prove most unsatisfactory. The reader may find a complete account of all the typical structures in Starling's admirable work on the subject.*

Besides their primary functions, the dikes have a further most useful one, for in nearly all instances they sustain paved or graveled



OUTWATERING SLUICE AT KATWIJK.

---

* "Some Notes on the Holland Dikes." By William Starling, M. Am Soc. C. E. *Transactions* American Society of Civil Engineers. Vol. XXVI. June, 1892. Norman Medal Paper. The cuts on pp. 220, 221, and 222 are used with the kind concurrence of the author and the permission of the society.

roads of most excellent character: in some cases they form railroad embankments.

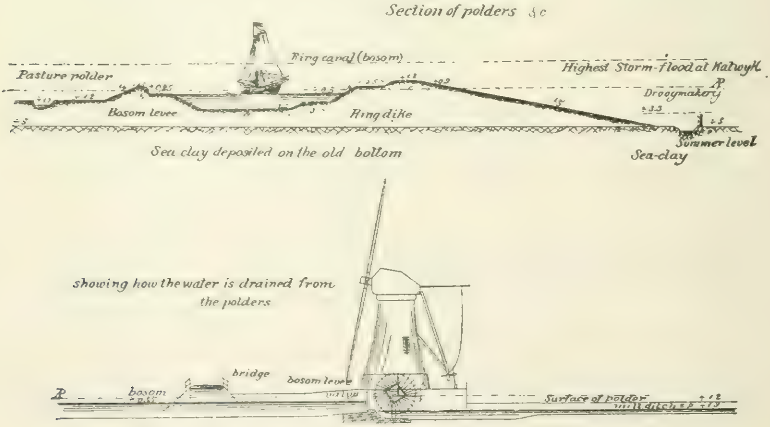
Plate 5 gives a typical polder, with all its characteristics, the mills being arranged "een gang," or series, on account of limitations of lift; it really shows one of the very early examples, for, when Beemster Lake was drained in 1612, forty-four mills were erected, arranged in eleven gangs of four each, which were necessary to drain 28 sq. miles.

While steam power is coming more and more into use in Holland for drainage purposes,—chiefly because there are too many calm days,—it is interesting to note Mr. Starling's statement that there were still in service in 1892, in the Rhineland district, two hundred and sixty wind-mills for drainage, exclusive of Haarlem Lake, which is served wholly by steam, the Cornish engines which were built to pump it out in 1848 being still employed.

This Harlaam-mer-Meer operation still "holds the record"; its polder covers 70 sq. miles; its ring dike is 17 miles in circumference; more than three years' pumping with 1200 h. p. was required to drain it, and the entire work consumed 12 years,—from 1840 to 1852.

The next in importance, of late years, are the results of the construction of the Amsterdam North-Sea Canal, 1872 to 1878, consisting of eleven polders aggregating 23 sq. miles.

But all are dwarfed into insignificance by the works in contemplation in the Zuyder Zee, which will comprise 18 miles of sea dike; reclaim 211,830 hectares, of which 187,000 (equivalent to 720 sq. miles) will be fertile arable land; require 17,000 h. p. for pumpage;



A TYPICAL OPERATION.

consume 33 years in building; and cost, including interest, 315,000,000 florins, equivalent to $126,000,000.

Next to the sea-dikes the most vital features of all are the sea and river outlets. Where these also serve for navigation, locks, of massive and very perfect construction, are employed. Otherwise what is known as an "outwatering sluice" is used, consisting, in general, of a masonry culvert with gates. The larger examples are very elaborate structures, and even the smallest must be built and maintained with greatest care and skill, placed, as they are, in earthen dams and working under considerable head.

The largest and most celebrated, built in 1807, is at Katwijk on the North Sea. Mr. Starling mentions it as the finest work of its kind in Europe. It is a "flushing sluice," the inner water being accumulated to obtain sufficient head to sweep away aggregations of silt, or of sand thrown up by the sea. If the inner water is insufficient, sea-water is admitted, at the flood, into an intermediate chamber, 1500 meters long, between the innermost and outermost gates. (See cut page 221.)

I again refer the reader to Mr. Starling's work for the details of the locks and outlets; also to Wheeler's "Drainage of Fens and Lowlands" for descriptions of the mechanical features of the large drainage plants, notably that at Katwijk, the largest in Holland at present.

We have, however, larger pumping plants in the United States, and it is interesting to note in passing a statement by Professor Telders of Delft, in a monograph on the subject, that the newest Dutch plants contain American pumps.

The proper maintenance and administration of the polder system are as important as its enduring construction. The State—that is, the Crown—provides for and assumes the construction and control of all the great works, but it administers and maintains only such features of them as are essentially for general public use. By the constitution of 1848 the Crown has the supervision of everything that concerns the *Waterstaat*, including roads and bridges; but the entire system of polders is cared for by colleges of administration, or, as we would style them, local boards, elected by the proprietors, who pay the necessary expenses (which average about $1.00 an acre annually, roughly speaking) in proportion to ownership, the polder land being divided into small holdings and sold. Sometimes there is a separate organization for each polder, but, where several use a common *boesem*, or where some other economical reason exists, their control is united in one body known as a *Waterschap*. In either case the principle is the same,—*viz.*, what is necessary for the conservation of the kingdom is paid out of the public purse; whatever special benefit accrues to the users they pay for directly, and it is thus made their vital interest to keep up the entire safety and thorough efficiency of the system. In the Zuyder Zee reclamation the direct cost to the Crown will be in round numbers at the rate of $275 per American acre of arable land, less whatever is obtained from subsequent sales to individuals. The value to the nation is not, of course, measured by this price, for, besides providing an additional bulwark against the sea, the reclamation means new farms and homes for at least half a million people.

More than half the 1500 miles of Holland's coast line and 500 miles of her rivers are diked: the inner dikes can scarcely be estimated. Yet all that vast and costly work is but a part of what these intelligent and indomitable people have done for themselves. I need only enumerate four great works, recently finished or still in progress,—*viz.*, the Amsterdam Ship Canal, costing $14,000,000; the new Rotterdam water-way, $13,000,000; the Merwede Canal, $10,000,000; the New Maas Mouth, $6,000,000: in all, $43,000,000 spent for better navigation by a population of but 4,500,000.

The "great drainage period" for the United States will come in the twentieth century. Millions of acres in the Mississippi valley, along the Missouri, on the Wabash bottoms, in the water-logged eastern Carolinas and Florida, and elsewhere, seem already to invite a new type of agricultural capitalist, but the time is not yet ripe for execution. Meanwhile we have ready to our hands this wealth of Dutch experience. Our problems will be simpler, perhaps, in some respects, and differ largely in others, but in the main they have all been encountered and admirably solved by the engineers and the statesmen of Holland.

EDUCATIONAL INFLUENCE OF MACHINERY.

By Alexander E. Outerbridge, Jr.

AN impression prevails in the minds of many intelligent people, more especially, perhaps, among those who are not directly engaged in mechanical pursuits, that the tendency of modern methods of manufacture in the substitution of machinery for hand-labor is detrimental to the intellectual development of the wage-earner in that it makes him an automaton, like the machine which he tends; that the workman in a great factory loses his individuality; that the handicraftsman of a former generation has disappeared, and that his successor is a mere marionette, to whom the gift of brains is a superfluity.

It is the object of this paper to present briefly a different and, in some respects, a novel view of the educational influence that machinery exerts upon the mental and moral development of the workingman, and to show that the introduction of new inventions, so far from being an oppression to the wage-earner, is, in fact, his greatest boon. These conclusions, which are the result of daily observation for a number of years in large industrial works, are at variance with the opinions of those theorists and economic writers who maintain that mechanical occupation is necessarily narrowing to the intellect.

While freely admitting that the high school and the university are magnificent—indeed ideal—educational forces (of which, however, only the privileged few can avail themselves), I shall hope to prove that the lathe, the loom, the locomotive, and hundreds of other machines, great and small, are doing their share, day after day, to elevate the less favored masses to a higher social and intellectual plane.

Through the educational influence of machinery the operative of to-day is not only the peer, but the superior, of his predecessor in all the qualifications that form the mental gage by which we may measure the intellectual and social relation that an individual bears to the community in which he lives. The mechanic of to-day, who is engaged, for instance, in riveting a boiler, or a bridge structure, no longer spends ten hours a day in striking blows with monotonous regularity with a hand-hammer upon the rivet heads, but he is employed to control the steam or hydraulic riveting machine,—a sort of giant hand, which presses the red-hot rivet into place, with a single silent squeeze of its powerful finger, far more effectually than can be done by two strong men striking one hundred blows each with a riveter's hammer. Indeed, at an official test, made some years ago, it was found that to drive an ordinary 5/8 in. rivet by muscular power required about two hundred and fifty blows of the hammer; and then the work was imperfectly done, for the reason that sufficient pressure cannot be given by such midget taps to the metal while still plastic to cause it to flow into all the irregularities of the rivet-holes.

It is not surprising that a stitching machine with such capabilities should have superseded hand-riveting of metal sheets as completely as the sewing machine has usurped the place of the seamstress's needle in stitching cotton sheets.

Innumerable illustrations of the amelioration of exhausting labor by substitution of powerful machines for puny arms could be given. Look at a great steam hammer giving, at one moment, herculean blows in rapid succession, and at another such gentle strokes as to crack the shell of an egg without smashing it! This is truly "the iron hand in the velvet glove," and the leviathan is perfectly controlled by a boy at the throttle.

With respect to the educating and elevating influence of machinery upon the mind of the workingman, I wish to present three distinct, yet closely related, propositions.

First: the educational power of the machine itself.

Second: the intellectual force of the inventor incorporated in the machine and influencing the mind of the operator.

Third: the educational and refining influence of the products of machinery through the cheapening of the cost and concurrent widening of distribution.

I.—THE EDUCATIONAL POWER OF THE MACHINE ITSELF.

I am satisfied that an insensate machine, in the material combinations of which, however, the skilled designer "has embodied his own mental faculties, so that it is constrained to do his will when power is applied," performing accurately the most complex operations, exerts a stimulating educational influence upon the care-tender, even though he may be an illiterate man or boy entirely unconscious of this influence. If you give a boy of average capacity the simplest routine work to do in connection with a machine,—it may be merely to feed it with raw material,—he will, at first perhaps, perform his task in a perfunctory manner, taking little interest in the work and having no comprehension of the mechanism of the machine. Little by little, however, the constant repetition of mechanical movements, producing always one uniform result, impresses itself upon his latent powers of observation and comprehension, the underlying principles and heretofore hidden motive of the seemingly inexplicable combination of wheels and gears is revealed, and simple order is evolved out of complexity; a new interest is developed and the boy becomes an intelligent operator.

On revisiting the establishment after a lapse of time you may find the same machine, and the same, yet not the same, attendant ; he has become, it may be, an expert ; he is now, perhaps, the master of the machine, knowing its imperfections and sometimes even suggesting improvements which had been previously overlooked.*

Remarkable testimony to the educational power of machinery was furnished by the wording of a certificate accompanying an award of the "Grand Diploma of Honor" by the International Jury of Awards of the World's Fair in Vienna, in 1873, to an American exhibit of machine tools,—*viz.*, "designed to bear the character of peculiar distinction for eminent merits in the domain of science, in its application to the education of the people and the advancement of the moral and material welfare of mankind."

The educational influence of mechanical ocupation upon the workingman is strikingly illustrated in another manner. You will find in all large industrial establishments employees who exhibit as much skill in their special work as that of well-known original scientific investigators ; they are daily performing operations as delicate in their way as the work of the microscopist, and with a degree of accuracy amazing to the novice. Take, for example, the simplest operation of calipering a tube, or measuring a rod, and you will find mechanics dealing quantitatively with minute fractions of an inch which ordinary people totally disregard.

In many modern machine-shops you will find mechanics to-day measuring electrical forces, using instruments and formulæ which but a few years ago were the subject of profound mathematical discussion and experimental research by Lord Kelvin and other world-renowned investigators, and which resulted in an international congress to establish the units of electrical measurement.

The educational influence upon the operative of daily contact with machinery is thus, in my judgment, a potent one, enlarging his mental horizon, giving him more accurate perceptions of the true relation of parts and fitness of things, and elevating him intellectually above the average plane of the skilful handicraftsman.

---

*In the course of an address upon "The Relation of Invention to Labor," delivered by the Hon. Carroll D. Wright, commissioner of labor, on the occasion of the celebration of the beginning of the second century of the American patent system at Washington in 1891, Mr. Wright said : "If the lowest grade of employment leads to self-respect, and the dignity and repose even which come of self-support (a proposition which cannot be denied), how ennobling must be that employment which not only stimulates the highest faculties, but also excites admiration for the perfect and love for the beautiful ! A man cannot superintend the movements of a complicated piece of machinery and not feel this working influence, and, maybe, become the better for his experience. His mind intuitively takes on the harmony of action, and finds itself running in tune to something which represents embodied thought. Any man witnessing the operations of the wonderful mechanism of the needle machine feels a continued influence from his observations. There is something peculiarly educational in the very presence of the working of mechanical powers."

The most perfect machine ever constructed only approaches, never realizes, the ideal of its designer or constructor, and it is, therefore, impossible to entirely eliminate the "personal equation" of the operator. Look, for example, at a modern iron planing machine (which is an embodiment of all the tool virtues that can be enumerated) taking a final scraping cut from the surface of a piece of metal; though this surface may seem to your sight and touch as smooth as a mirror, the inspector will casually rub his finger over it and detect ridges not exceeding, perhaps, a few thousandths of an inch, the work resembling to him a ploughed field, in which, if the furroughs exceed a most minute allowance, the work must be repeated again and again, until the the microscopic imperfections of the man and of the machine have been eliminated from the work; indeed, wherever absolute truth is required in bearing surfaces of metal, hand-scraping is still the final resort.

It is, therefore, not merely the ability to turn out a maximum amount of work from any machine tool which constitutes the skilled mechanic. No matter how nearly automatic the machine may be, it is still subject to human guidance; and, no matter how nearly perfect its construction, its work is still subject to final correction by that most wonderful of all machines, the human hand guided by the human mind.

The limitations of this paper will not permit us to pursue further this interesting psychological phase of the subject; let us pass, then, to the consideration of the second proposition.

II.—THE INTELLECTUAL FORCE OF THE INVENTOR.

I believe that every novel machine possesses something of the personality of its creator. I believe, furthermore, that it is possible to trace though the machine, back to the inventor, a positive and continuing influence of his mind upon the mind of the operator.

I believe that the special mental development of the present generation of American engineers and mechanics may also be traced through historical relics to the subtle quality of mind with which famous American inventors have endowed their creations; these forces have been silently working to mould the minds of men in characteristic grooves, so that it is as impossible to mistake a purely American machine for a foreign production as it is to mistake a Chinaman for an Indian. This characterization may be even more sharply defined; it is not an unusual observation among mechanical experts to-day that machines produced by one establishment may often be distinguished from similar machines of another make (without the aid of any name plate) through a peculiar "something" which the Frenchman expresses with a shrug and "*Je ne sais quoi.*"

To further elucidate the novel idea, contained in my second proposition, I will ask you to suppose that a number of inventors, who are living in different parts of the world, surrounded by different environments, and having different experiences, conveniences, and necessities, are all engaged independently, at the same time, in solving some new problem in mechanics, or in designing some novel machine to perform special work (we have had many such illustrations in recent years in the numbers of new inventions in connection with the employment of electricity for utilitarian purposes). You will find that different minds evolve different methods of accomplishing one ultimate result.

One inventor will proceed by the most direct method to attain the final end; another will take a more devious course, and produce, it may be, a more complicated machine; yet it may also be difficult to decide upon their relative merits, since one may gain in refinement and accuracy what it loses in other features. Each machine exhibits in its design the mental process of the inventor, and each has, therefore, a distinct individuality incorporated in it, emanating from its creator, and this in turn exerts a continuing influence upon the mind of the operator.

Numerous citations could be drawn from historical inventions to illustrate the views here advanced, but our own period and country afford the most interesting examples of personal characteristics impressed upon inert matter and incorporated in the machine. Those who are familiar with the startling discoveries and inventions of the brilliant and original mind of Tesla may not, perhaps, find it difficult to trace a resemblance between the man and his creations which is more than mere idle fancy.

The inventor of that marvellous machine, the phonograph, which will forever proclaim the name of its creator in sounding words of praise, has woven his mental characteristics into its simple combinations of inert matter so that they are differentiated from all other aggregations of such materials, and, although the practical uses of the instrument have not been fully developed, I believe that further study of the apparatus is destined to exert a decided influence upon the trend of thought and invention in other directions as yet unexplored, and that it is an "epoch-making invention," which is therefore peculiarly suitable as an illustration of my theories.

III.—PRODUCTS OF MACHINERY VS. HANDICRAFT.

The cheapening of manufactured articles through the aid of machinery is always followed by an equivalent increased demand, the former luxuries of the rich thus becoming ordinary conveniences in the economies of life; moreover, new occupations are provided for thousands, nay, hundreds of thousands, of working men and women in the manufacture of all that appertains to such machines.

It is true that temporary disarrangement of various trades has occurred through the invention and rapid introduction of machinery with which hand-work could not compete ; but re-adjustment to the changed conditions has quickly followed with ultimate beneficial results to the wage-earner.

Whatever view we may entertain upon this subject, it is a pleasure to note that, at the present time, we seem to have entered upon a formative period in the history of the world's industrial work.

The destructive period, or the breaking down of handicraft by machinery designated by Mr. Wright as the "contraction of labor," has been practically accomplished, and the recent grand inventions do not entail the displacement of hand-labor in any form, but, on the contrary, have been direct creators of new industries representing already the investment of many millions of dollars and giving employment of lucrative and elevating character to vast armies of wage-earners in entirely new fields.

Within the past decade new industries connected with the application of electricity to utilitarian purposes have sprung into existence as if by magic, and have at once taken front rank, outstripping in importance, in wealth, and in the numbers of active workers employed therein, many trades and professions inherited from former days. These are the giants of this formative period.

Few persons, even among those who are foremost leaders in these new occupations, realize what gigantic forces have thus been developed in the industrial world within this very brief period. It is impossible to forecast what the future may bring forth ; even though no further discoveries should be made in fundamental principles, sufficient new "raw material" is already provided, waiting to be woven into our industries, to assure a condition of activity for years to come.

Contrast the life and environment of the operative to-day (ignoring the temporary disarrangement of industrial laws and operations through ill-devised financial and tariff experiments) with the worker of a past generation. No longer will you find men, women, and children crowded together in dimly-lighted, ill-ventilated, small rooms, often used as working and living apartments [of course, I exclude the criminal "sweat-shop" system of the tailor's trade], but in all the large industrial establishments you will notice that air, light, heat, and sanitary arrangements, as well as provision for the comfort and convenience of the employee, have been carefully considered. The operative is no longer regarded as a mere machine, but as an intelligent being, whose business it is to control machines.

Whence comes this superior intelligence of the modern wage-worker? Is it not largely due to the influence of machinery, embodying in itself the material essence of the mind of the inventor, with which transmuted influence he is brought into daily contact? Does he not earn, and receive, larger wages by reason of this acquired superior ability, and is he not enabled, through the cheapening of all machine products, to purchase comforts, conveniences, and luxuries that were entirely unknown to his ancestors? Have we not shown that the machine is as tireless a teacher as it is a worker, and that, instead of proving the workingman's enemy, it is his truest friend?

Should the reader desire optical demonstration of all that has been here claimed, he should visit "modern Philadelphia," known as the city of homes for workingmen; taking the workingman's swift modern conveyance, he may speed through miles and miles of smooth streets, paved with asphalt, and view thousands of neat, even elegant, little homes, occupied and owned, in large part, by workingmen; he may enter these homes, as I have done, and find many appointments which he has been accustomed to regard as luxuries of the wealthy contributing to the comfort, convenience, and mental and moral elevation of wage-earners composing such families.

I am not drawing an imaginary, or even an exceptional, picture, but only stating facts which can easily be verified, and which are sufficient in themselves to prove that the introduction of new machinery, so far from being an oppression to the workingman, is his greatest boon; and I think the reader will then agree with me that, while the university and the high school are grand educational forces, the loom, the lathe, the locomotive, and hundreds of other machines, great and small, are doing their share, day after day, to elevate the less favored masses to a higher social plane through the educational influence of the subtle mental force with which the inventor has unconsciously endowed the combination of inert materials forming his machine.

That mind and matter can be so united as to constitute a distinct force or quality will seem, at first glance, merely a quaint fancy, but I am more and more convinced, through daily observation, of its actual entity; and it is, after all, not more strange or mysterious than is the fact that we may to-day listen to the fleeting voices of sweet singers and of great thinkers who have "passed beyond," through the aid of that simple combination of dead matter the phonograph. *

---

* In advancing these views, I wish to disclaim all association or sympathy with those vague impressions of day-dreamers which are variously designated under the names of "Spiritualism," "Animal Magnetism," "Psychic" or "Odic force," etc. Nevertheless I repeat that I believe that every novel machine possesses something of the personality of its creator, and, further, that this quality exerts a continuing influence upon the operator.

THE GREAT STEAMERS OF LONG ISLAND SOUND.

By William A. Fairburn.

THERE is a magnificent fleet of passenger-vessels now navigating our numerous lakes, sounds, and rivers, of which by far the most interesting and important are the steamboats engaged in the "Long Island sound" trade. They are not only unequaled, but even unapproached, in the world, for size, safety, capacity, and speed ; for magnificence of decoration, perfect comfort, and luxury of appointment. Soon after Fulton had proved the practicability of steam-propulsion on the Hudson river, he turned his attention to the navigation of Long Island sound, which at that period was considered very hazardous. Accordingly the Fulton was built in the early part of 1814, and on March 21, 1815, she made her first trip on Long Island sound,—being the first steam-vessel to navigate those waters. The Fulton depended on her sails to accelerate her speed, and her first trip to New Haven was accomplished in 11 hours, the return being made in 15 hours, in foggy weather.

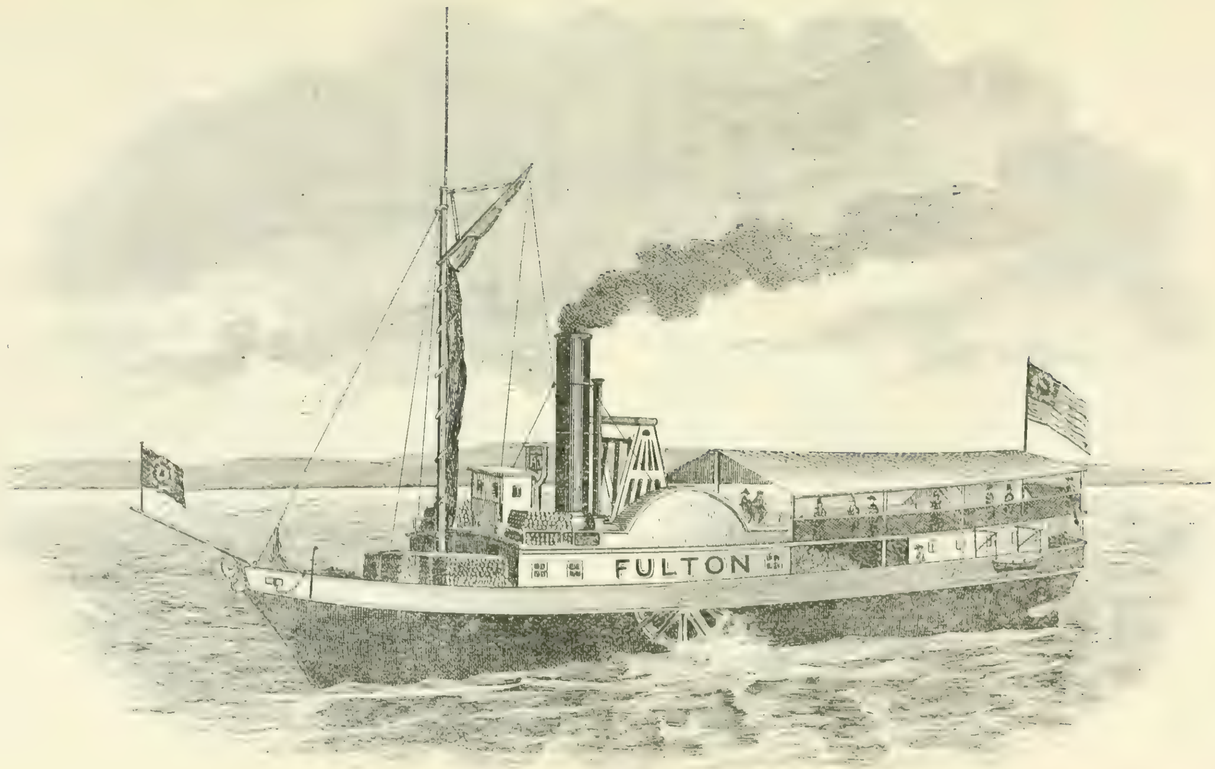
On May 25, 1817, the Hudson river steamboat Fire-Fly made the trip up the sound from New York to Newport in 28 hours, —the first steam-vessel to round Point Judith.

In 1818 the Connecticut appeared on the New Haven route, and continued to run until May, 1822.

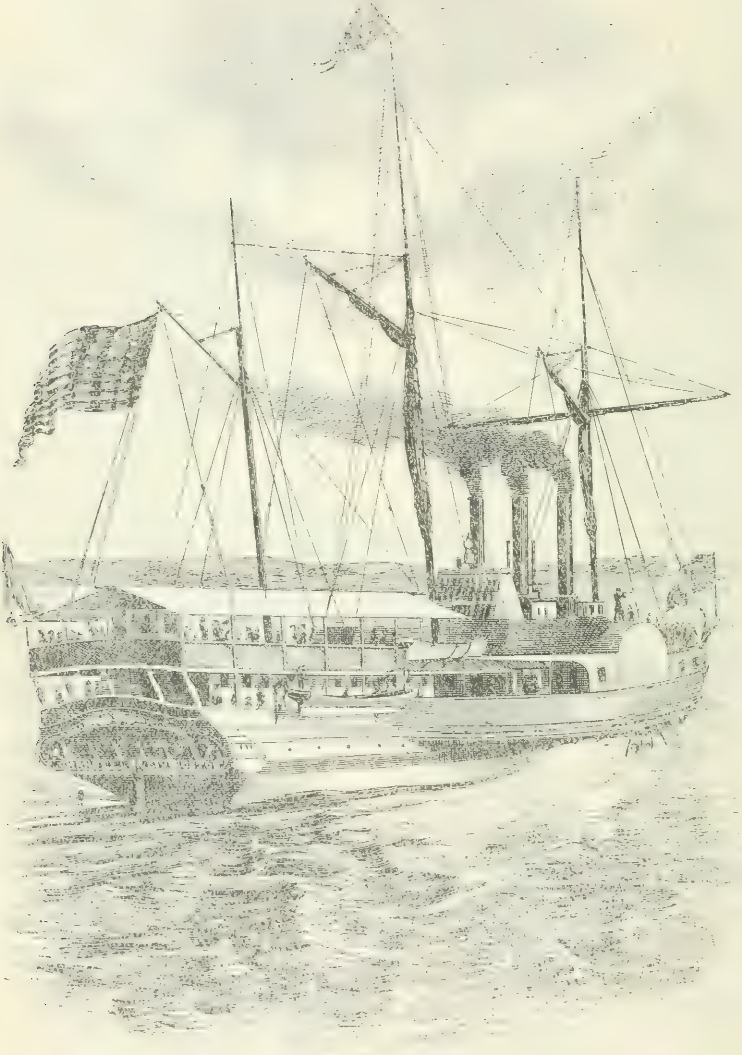
During November, 1821, a New Haven syndicate purchased the steamboat United States, which lay in New Jersey in an unfinished condition, and this vessel became the nucleus of the present New Haven Steamboat Company.

About this time the prohibitory laws of New York State forbade the passing through her waters of any boat propelled by steam other than the Fulton-Livingstone vessels ; so the United States was towed to the sound by the sloop Huntress. On June 1, 1822, she made her first trip to Byran Cove, which was on the boundary line between New York and Connecticut, and passengers were then transferred to stages, to finish the journey on land,—a drive of 25 miles.

These trips were continued nearly 2 years, and when, in the spring of 1824, the final decision of the famous case "Gibbons vs. Ogden" was rendered, reversing a decision in the court of errors and declaring the act of the New York legislature, in granting exclusive right of steam navigation to Fulton and Livingstone, unconstitutional, the vessel began



FULTON, 1815.



CHANCELLOR LIVINGSTON, 1828.

regular trips direct to New York city. While the Fulton-Livingstone Co. held the monopoly of steam navigation in New York waters, the Connecticut legislature retaliated by refusing to admit the vessels of this company to steam in their waters. So in 1822 the Fulton and Connecticut had to leave the New Haven Line.

The Fulton, in August, 1821, made an excursion to Providence, and on June 6, 1822, the Connecticut and Fulton established the first line between New York, Newport, and Providence.

In 1825 a great step in advance in sound steamboats was made by the appearance of the Washington. She is said to have been the first boat fitted with a double engine. The *Providence Journal* of March 16, 1825, described her as "a floating palace, combining all the elegance of naval architecture with the most luxurious accommodation."

In 1827 the Marco Bozzaris commenced making trips between Dighton and New York, but she did not stay on the route long, as the opposition was too strong. In March, 1828, the Chancellor Livingstone appeared on the Providence route. In September the Benj. Franklin made her maiden trip, and on November 7, 1829, the famous President joined the line.

The *Providence Journal* said of her: "What further improvements yet remain to be made in steamboats we cannot imagine; to us and our generation the President must appear the *ne-plus-ultra.*" The President was the first boat to be fitted with state-rooms; she had no sail.

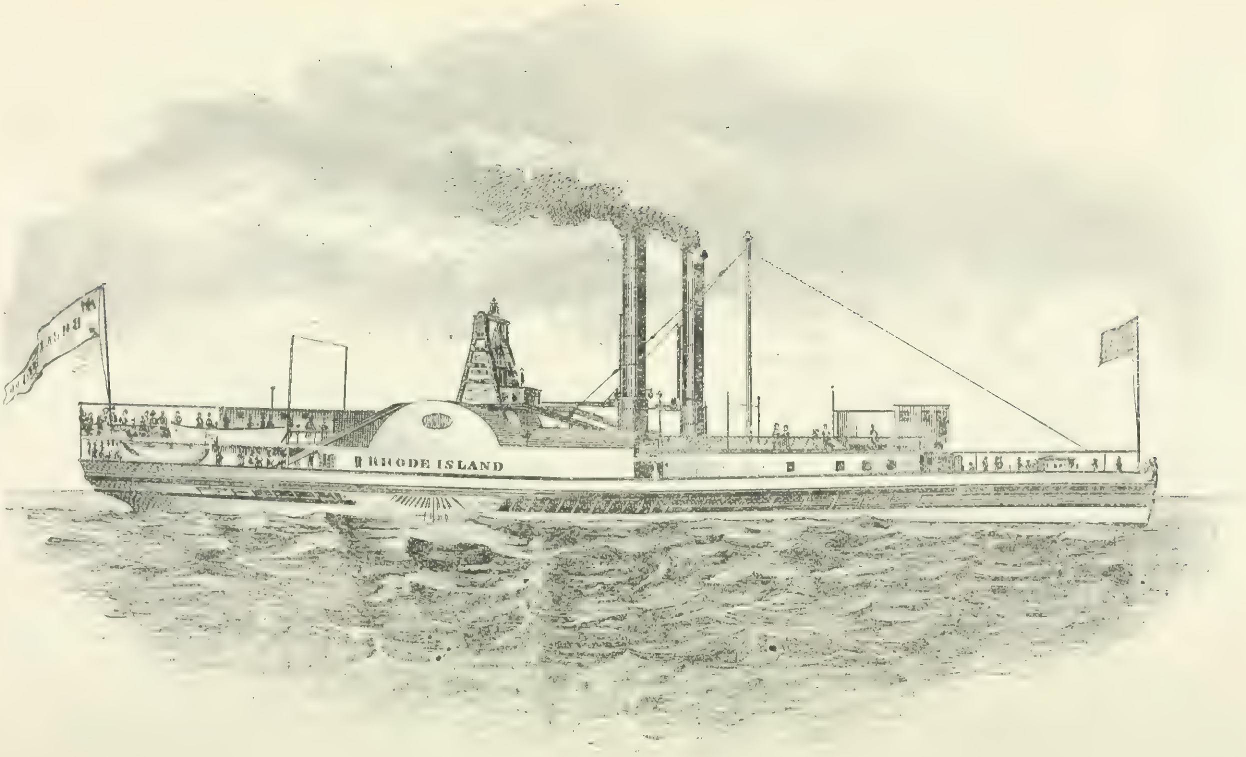
In 1831 the Boston commenced making trips up the sound; she was the first steamboat built without a mast. In 1832 the Providence appeared on the New Haven Line, and later on the Providence route. She was of 350 tons burden, and had a beam engine,— the first seen on the sound.

The old Connecticut made her last appearance in 1833, and in 1834 the Chancellor Livingstone was sunk in Boston harbor. In June, 1835, the famous Lexington made her first trip up the sound.

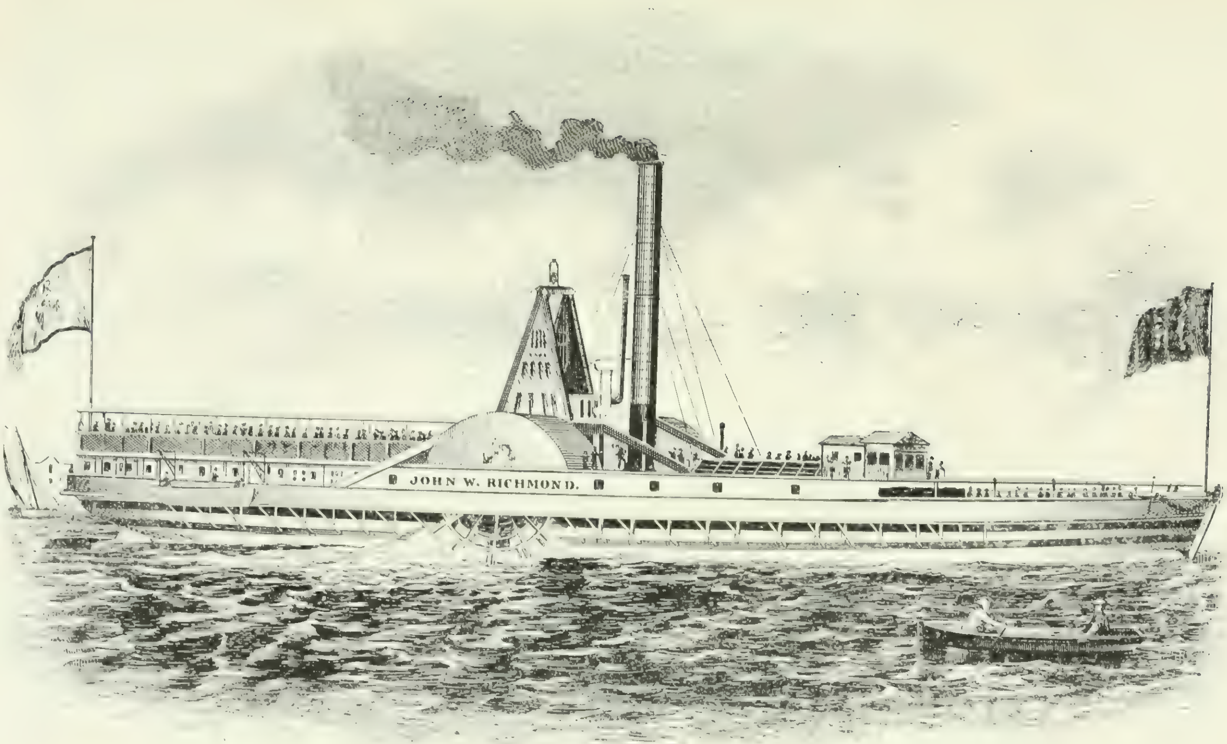
The next great step in advance was made a year later by the appearance of the Massachusetts, Rhode Island, and Narragansett. These boats were the first that in any way approximated modern steamboat architecture, and they were all much larger and better equipped than their predecessors.

The Boston was sold in 1838, and the President and Franklin made irregular trips until 1839; but their glory was fast waning, and they ultimately degenerated into coal-barges.

The railroad cars began to connect with the steamboats at Providence in June 15, 1835, and therefore the through line, New York to Boston, with steam as a motive-power, was formed. On November



RHODE ISLAND, 1836.


JOHN W. RICHMOND.

JOHN W. RICHMOND, 1837.

10, 1837, the Providence and Stonington Railroad was opened, and the Rhode Island and Narragansett at once made Stonington their terminus. In 1837 the John W. Richmond of the Atlantic Steamboat Company appeared on the route. At first her boilers were placed on deck, but, when one day she capsized at her wharf, it was thought advisable to put them below. She was sold in 1840 for $52,500, and plied on the Kennebec until burned in 1843. The Eureka made her first trip up the sound in 1840, and on January 13 of the same year the Lexington was burned at sea, off Huntington, Long Island; one hundred and five lives were lost.

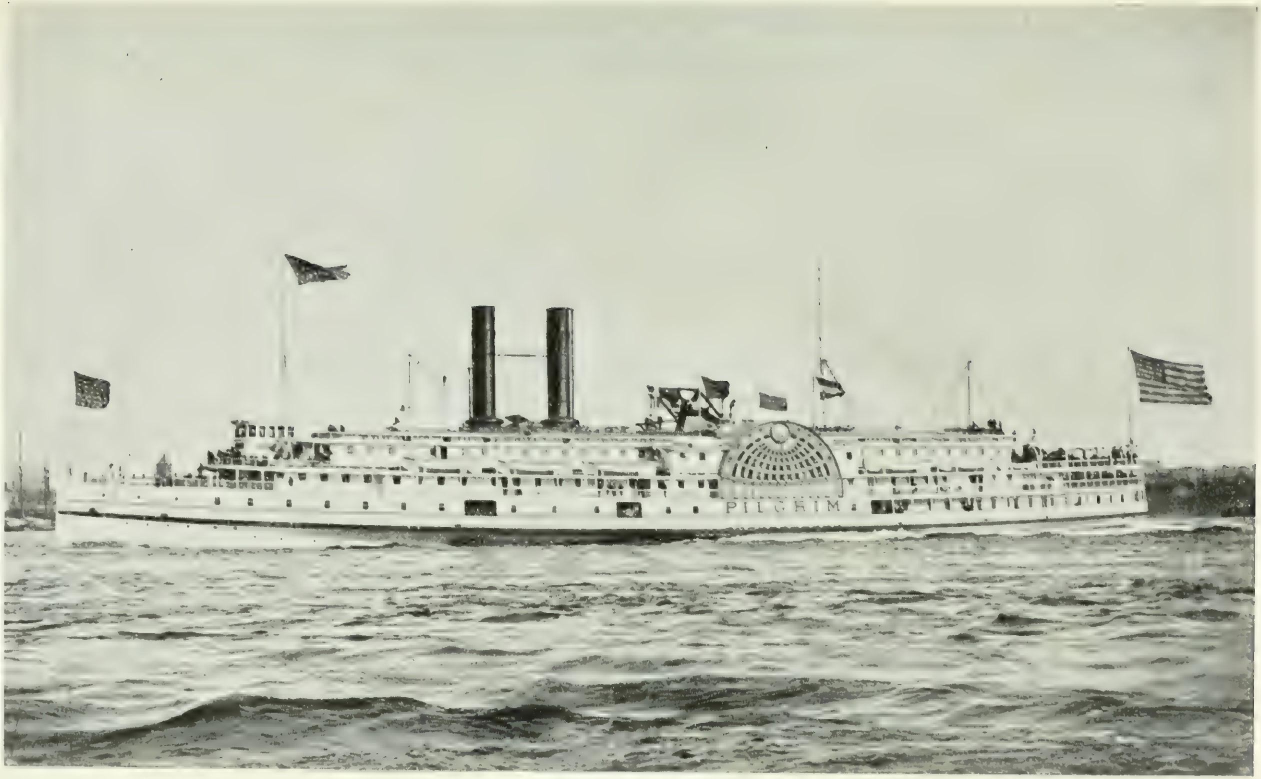
At this period the Providence line was beginning to lose its importance, and passenger travel was inclined to go by the way of the inside routes. In 1847 the well-known Connecticut (No. 2) appeared on the New Haven route; she proved a popular, speedy vessel, and had an engine with a 75-in. cylinder and 144-in. stroke. The same year the Fall River Line to Boston was inaugurated by the Bordens of Fall River. The boats were now withdrawn from the direct Providence route, and the Narragansett and Rhode Island were sold, went south, and were finally lost at sea.

The Fall River Line commenced with the Eudora, built in 1845; then came the Bay State, the finest specimen of marine construction of her class, in her day. The Empire State appeared in 1848, and in 1854 the well-known Metropolis joined the line. This vessel was for many years the queen and greyhound of the sound, and she was the first boat braced with diagonal iron truss work.

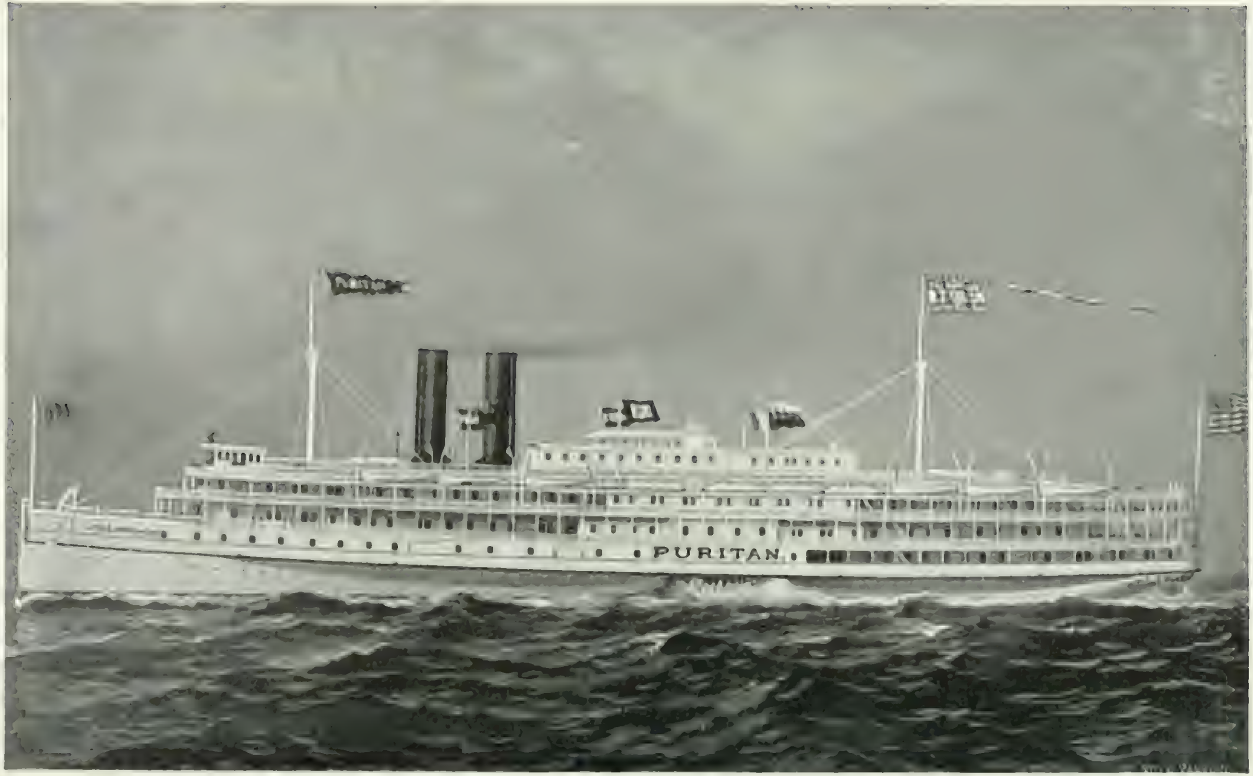
In 1864 Newport was made the eastern terminus for the Fall River Line boats, but in 1869 the terminus was again established at Fall River. In 1865 the Newport and Old Colony were built, and in 1867 the Bristol and Providence were added to the line. The latter vessels achieved a world-wide reputation for comfort, speed, and elegance, and the Providence still remains as one of the largest vessels on the sound.

In 1851 the Commercial Steamboat Company was organized, and ran the propellers Pelican, 350 tons, Osceola, 177 tons, and Petrel, 267 tons, to Stonington; and in 1855 the company started a day line to New York, adding the Curlew and Westchester, and later the Albatross, Penguin, Falcon, Eagle, Seagull, and Kingfisher. In 1863 the Neptune Line was organized with the Warrior, 1500 tons, a side-wheeler, and a few years later the small propellers Electra, Galatea, Oceanus, Metis, Thetis, Doris, Nereus, Glaucus, and Neptune were put on the route.

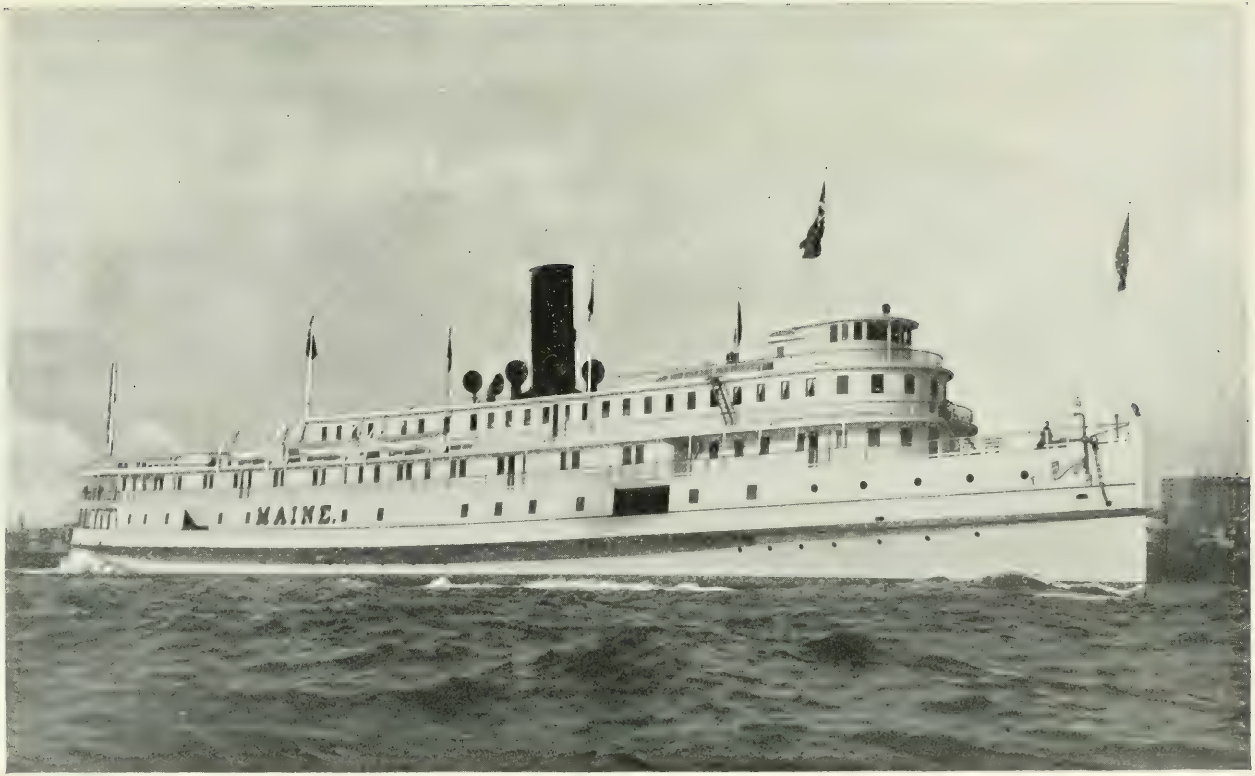
In 1864 the Commercial Line sold its boats to the Neptune Line, and in 1866 the Neptune and Stonington Line were consolidated, the



PILGRIM, 1883.



PURITAN, 1889.



MAINE, 1891.

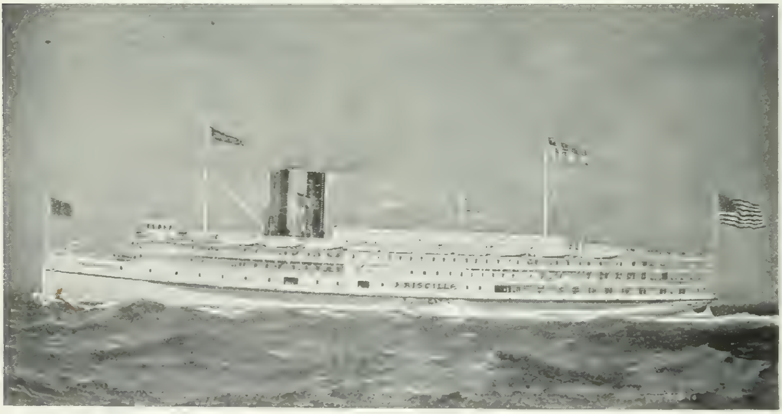
new line being known as the Merchants' Steamship Company. It added to the vessels owned by the Neptune Company the Commonwealth, Commodore, and Plymouth Rock: and Groton on the Thames was now made the terminus. Presently the company sustained heavy losses. First the Commonwealth, one of the most magnificent vessels on the sound, was burned at her wharf. She was a total loss, and was not insured. The docks being destroyed at Groton, the terminus was now changed to Stonington, and then the Commodore went ashore, and was a total loss. A little later the Plymouth Rock grounded at Saybrook, and was seriously damaged. The line was suspended, and the Bristol and Providence, then just being completed, and on which $1,350,000 had been spent, were sold for $360,000.

The Merchants' Steamship Company went to pieces, and the stockholders received but 3 cents on the dollar.

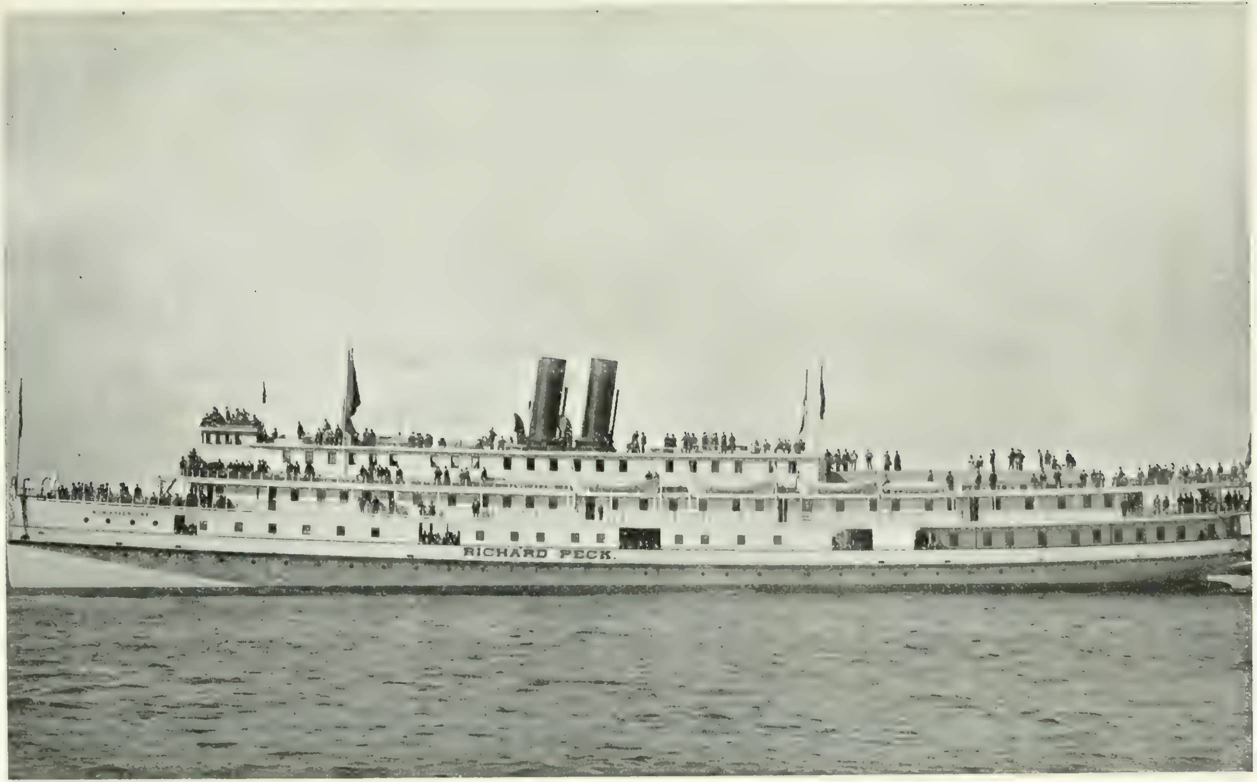
The Nereus, Glaucus, and Neptune were purchased by the Metropolitan Steamship Company: the Bristol and Providence finally went on the Fall River route: and the Neptune boats fell into the hands of the Providence and New York Steamboat Company.

In 1868 the Stonington Steamboat Company started again with the Narragansett and Stonington, and in 1875 it consolidated with the Providence Line, and both lines now operate under the name of the Providence and Stonington Steamship Company.

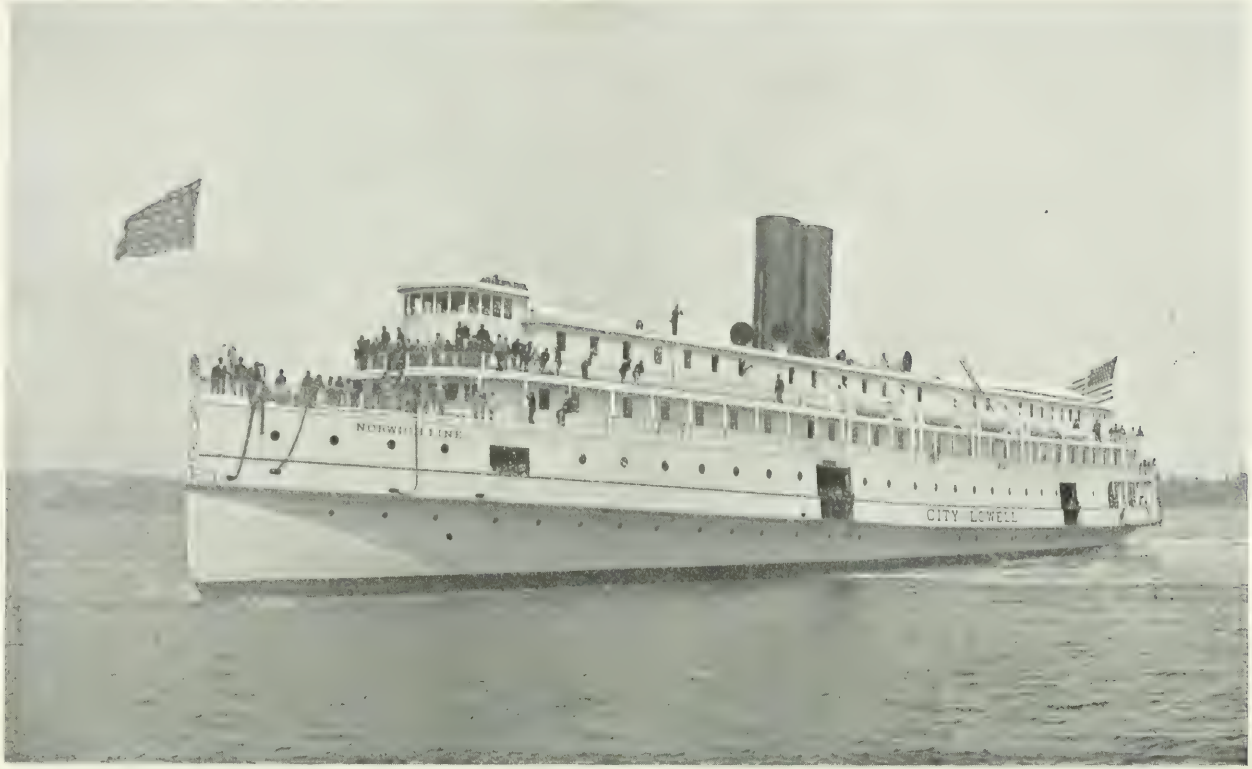
As before mentioned, the Fall River Line boats were joined in 1867 by the Bristol and Providence. It was at this time and for some years afterwards supposed that in these ships the limit of construction in steamboats of their class had been reached, so far as size and magnificence were concerned. Subsequent years have proved that they were little more than pioneers,—the merest prophecy of that



PRISCILLA, 1894.



RICHARD PECK, 1892.



CITY OF LOWELL, 1894.

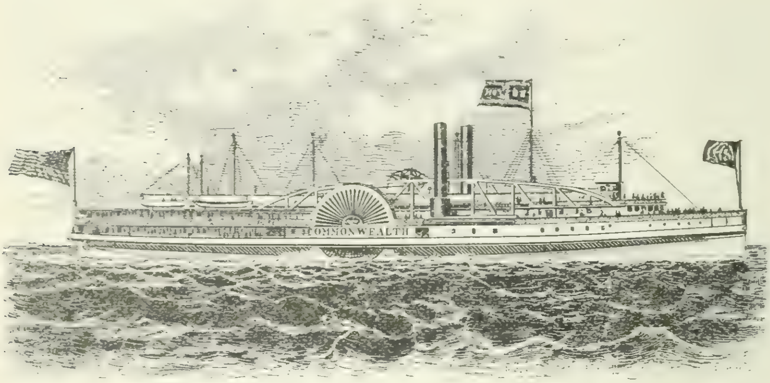
which was yet to be realized. They proved, however, the limit of construction in one direction; they are the largest wood passenger boats ever built for sound passenger transportation. In 1861 the Norwich Line for Boston was inaugurated, and since that time it has run the following vessels: City of Boston and New York in 1861; Norwich, 1862; New London, 1863; Lawrence, 1866; Worcester, 1881. The City of Norwich was sold in March, 1894, and the New London was burned November 21, 1871.

After the acquisition of the Bristol and Providence, 16 years elapsed before there was any further addition to the steamboats on the Fall River Line; but in 1881 the construction of the Pilgrim was commenced. She was launched the following year, and commissioned June 20, 1883. The Pilgrim far exceeded in size, capacity, and elegance any steamboat at that period afloat, and immediately upon her appearance in service she became known as the monarch of Long Island sound. She is built of iron, on the longitudinal bracket plate system, with a double bottom 36 in. in depth and minutely subdivided extending her whole length. The Pilgrim is worthy of especial notice, as she proved a pioneer in new directions in naval construction. She reduced many important and interesting theories to practice, and tested methods and appliances in her make-up that had theretofore existed only in the realms of experiment or proposed enterprise. Her machinery, electric plant, finishing, furnishings, etc., presented notable examples of progress.

That the Fall River Line owners were well pleased with the Pilgrim is doubtless true, but they were not entirely satisfied; and it soon became evident that a consort was needed. Accordingly in 1888 the Puritan was launched, and she was commissioned on June 17, 1889. The Puritan eclipsed the Pilgrim in every detail, thus showing the great improvement made in naval architecture during the previous 6 years. Upon her completion she at once took position before the world in accordance with her characteristics and qualifications, and therefore she immediately became the undisputed queen of the sound.

The Puritan is constructed of steel, and is undoubtedly a much handsomer vessel than the Pilgrim. In the first place, she has more freeboard, and this, with a neater sheer, gives her a more imposing appearance: then, again, the working beam in the more modern boat is cased in, the gaily ornamented paddle-boxes are done away with, and the compound engine is substituted for the unwieldly single-cylinder engine.

The Puritan was soon followed by the Plymouth, the latter vessel being launched in April, 1890, and commissioned in November of the same year. Although a trifle smaller than the Pilgrim and Puritan,



COMMONWEALTH, 1865.

this boat is very nearly identical with the latter in appearance and detail. She has, however, but one smoke-pipe and a four-cylinder inclined triple expansion engine.

But neither did the construction of these vessels, and their successful meeting of every expectation that had been centred upon them, satisfy the demands of the growing enterprise of the Fall River Line; and in June, 1894, a new boat, larger and more complete in every department than any that had preceded her, was placed on the route. She is known as the Priscilla.

From beginning to end the Priscilla is an artistic production, and this may be said without in the slightest degree detracting from the practical, and mechanical, in her make-up. Indeed, there is as much of the truly artistic in the arrangement of the great vessel, in the perfect working of her machinery, and in the correspondence of all her proportions, as there is in her ornamentations, decorations, and furnishings; howbeit, these last-named features were never excelled—probably were never equalled—in any vessel of her class.

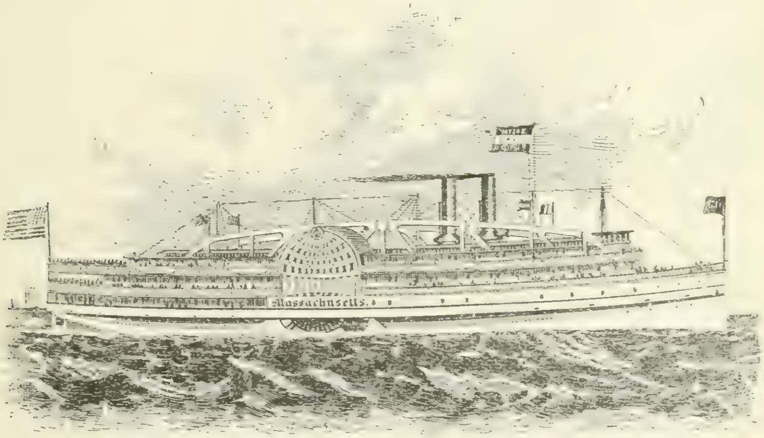
The Priscilla stands to-day as the finest exponent of marine construction of her class in the world. As a passenger steamboat running upon an ocean route, characterized by the feature of both inside and outside navigation, she has no equal anywhere.

In the form of engine adopted in the Priscilla, the making of excessively large parts, such as the low-pressure cylinder and the beam engine would demand, is avoided, and the weight is kept easily below the safety-line. The double inclined engine, having practically no centers, lessens the vibration, and the vessel is in all respects exceeding steady.

One of the great features of the Priscilla is her strength of construction. Mild steel enters into the construction of this boat in every part. In the saloon and cabins, behind, and concealed by the elaborate finish, steel trusses spring from the decks at either side, and span in unbroken arches overhead from side to side, a succession of vertebræ only a few feet apart. Steel carlins, stanchions, and braces are judiciously fitted to afford factors of strength and resistance, and the result is one of the stiffest and least impressible marine buildings ever floated.

The Massachusetts, 1876, and Rhode Island, 1882, have proved good and profitable vessels to the Providence Line, and in 1889 the Connecticut joined them. The Connecticut is a fine vessel, and is no doubt the last of the wood vessels to be built for passenger service on the sound. In shipbuilding it has always been understood that, the larger the vessel, the less is her intrinsic strength, all other things being equal. It was to overcome this practical defect in the science of naval construction that iron was introduced as a shipbuilding material, and only by its use has the mechanic been enabled to produce the large, successful, and heavily-powered steamships of modern times. The great trouble with the Connecticut has been her inability to carry the ponderous machinery fitted,—a fault we will find in all heavily-powered wooden vessels.

In 1891 the Maine and New Hampshire displaced the Stonington and Narragansett on the Stonington Line, and the side-wheeler, which had always held undisputed sway on the sound, was supplanted in these two steamers by the propeller. The fact that the power of these vessels is concentrated on one propeller necessitates the use of a fairly large wheel. As the boats draw but 12′ 6″ of water aft when loaded,



MASSACHUSETTS, 1876.

and as the propeller has a diameter of 13′ 6″, about 2 ft. of the tips of the blades is out of water, and this accounts for the great commotion noticeable around the stern when steaming.

In 1892 a new type of steamboat appeared,—*viz.*, the Richard Peck, of the New Haven Line. At that time the Puritan was the greyhound of the sound, but she soon had to give the pennant for speed to the new-comer, who defeated her by about 2 miles in a 56-mile run. The Richard Peck is a twin-screw steel steamboat, and she was designed by A. Cary Smith of New York. She is a very handsome craft, having splendid lines, with a fine, rakish, yacht-like appearance, and carrying a dainty, jaunty air.

When the Priscilla appeared in June last, she at once took the pennant and steamed majestically away from all her rivals; but this was not destined to last long, for a month later the steel twin-screw steamship City of Lowell of the Norwich Line came on the route. The Lowell was built by the Bath Iron Works of Bath, Me., and modelled by A. Cary Smith. She was designed as an improvement on the Richard Peck, and is a trifle larger, with more capacity, better finish, and greater speed. The lines and general smart appearance of the Peck were admired by all who saw her, but she does not compare with the Lowell in beauty and gracefulness. Immediately upon her com-

THE EARLY STEAMBOATS OF LONG ISLAND SOUND.

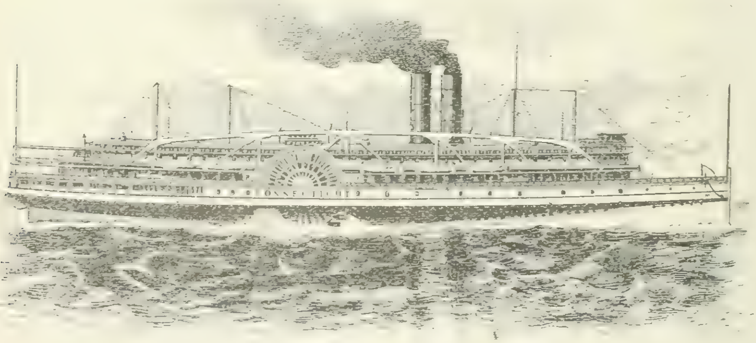
Name.	Year Built.	Gross Tonnage.	Length.	Beam.	Depth Hold.	Speed Miles.
Fulton	1815	327	134	26	10	7
Connecticut	1816	320	150	26	10	7.5
Washington	1825	530	180	30	10	8
Chancellor Livingston	1828	496	165	32	11	8.5
Benj. Franklin	1828	468	160	31.5	10	10
President	1829	615	183	32	11	13.5
Lexington	1835	475	205	22	11.5	14
Massachusetts	1836	676	202	29	12	13
Rhode Island	1836	588	212	28	10	13.5
Narragansett	1836	576	212	27	10	13.5
John W. Richmond	1837	480	200	24	12	14.5
Bay State	1848	1600	317	40	14	16
Empire State	1849	1600	317	40	14	16
Metropolis	1854	2108	342	45	15	18.5
City of Boston	1861	1577	301	40	12.3	19
City of Norwich	1862	997	200	36	13.2	15
City of New London	1863	1203	219	38	14	15
Old Colony	1864	1957	310	42	14.5	17.5
Newport	1865	2151	361	43	14.5	17.5
City of Lawrence	1866	1678	243	38	11.9	17
Narragansett	1866	1633	253	40	15	17
Stonington	1866	1633	253	40	15	17

THE GREAT MODERN STEAMBOATS OF LONG ISLAND SOUND.

Name of Vessel	Providence.	Massachus'ts.	C. H. Nort'm	City of Worc'r	Rhode Island.	Pilgrim.	Conn'c-ticut.	Puritan.	Plymouth	Maine.	New Ham're	Rich'rd Peck	Priscilla.	City of Lowell.
Material Constructed of	Wood.	Wood.	Wood	Iron.	Wood.	Iron.	Wood.	Steel.	Steel.	Steel.	Steel.	Steel.	Steel.	Steel
Owners or Line	Fall River.	Providence.	New Haven.	Norwich	Providence.	Fall River.	Providence.	Fall River.	Fall River.	Stonington.	Stonington.	New Haven.	Fall River.	Norwich.
Designers { Hull		Steers.	J Englis	H.& H.	Palmer.	J. Roach.	Mallory	G Pierce.	G. Pierce.	Ha'n &	Ha'n &	Smith.	G. Pierce	Smith.
Designers { Machinery		J.Roach	Quint'd	Wilm'n.	J.Roach	Chester.	N. Y.	Fletcher.	Fletcher.	Holl'th	Holl'th	H & H	Fletcher.	C Hyde
Builders { Hull		Gr'np't.	J Englis	H.& H.	Noank.	J. Roach.	Palmer.	J Roach.	J. Roach.	H.& H.	H.& H.	H.& H	Del.R I S	B'th I'n
Builders { Machinery		J.Roach	Quint'd	Wilm'n	Roach.	Chester.	Cramp.	Fletcher.	Fletcher.	Wilm'n	Wilm'n	Wilm'n	Fletcher	Works.
Date Completed	1867	1877	1877	Sept.'81	May '82	June20,'83	June '89	June 1889	Nov. 1890	Mar.'92	Apr. '92	Oct. '92	June 1894.	July '94
Estimated Total Cost	$680,000	$400,000	$375,000	$430,000	$410,000	$1,220,000	$560,000	$1,225,000	$900,000	$385,000	$385,000	$435,000	$1,500,000	$465,000
Gross Tonnage—C. H. M.	2962	2007	1436	2490	2888	3484	3399	4593	3771	2395	2395	2906	5398	2975
Net Tonnage C. H. M.	2004	2171	1179	1922	2387	2513	1872	3079	2280	1505	1505	1819		1877
Displacement	3400	2600	1900	2250	3000	4200	3500	4150	3600	2000	2000	2300	4550	2368
Length over all	373′	340′	320′	345′	345′	390′	358′6″	419′4″	366′	310′	310′	315′	440′6″	336′0½″
Length. L. W. L.	303′	324′	315′	328′	329′6″	375′	345′	403′4″	351′8″	302′7″	302′7″	300′	423′6″	319′10¾″
Beam	47′6″	46′	46′	46′	46′	50′	48′2″	52′6″	50′	44′	44′	48′	52′6″	49′6″
Extreme Breadth over Guards	84′6″	76′	80′	80′	84′	91′	87′0″	91′0″	87′	60′	60′	62′	93′	66′1″
Mean Draft	9′8″	10′0″	9′6″	10′3″	10′2″	11′8″	12′0″	11′8″	10′10″	10′6″	10′6″	10′0″	12′6″	12′0″
Depth of Hold	16′	16′4″	17′	16′6″	16′	15′3″	18′3″	18′1″	17′9″	17′6″	17′6″	17′6″	18′6″	17′7″
Number of State Rooms		185	112	150	165	236	209	360	250	102	102	135	306	164
Passenger Berth Accommodation		360	505	510	334	700	528	920	710	240	240	520	1030	615
Number of Crew or Complement		112	95	90	115	150	120	185	155	60	60	95	206	107
Coal Capacity		120	50	125	120	80	130			80	80	60	200	90
Freight Capacity	500	357	430	425	455	550	552	700	600	500	500	530	800	600
Mode of Propulsion	Side wh'ler.	Side wh'ler.	Side wh'ler.	Side wh'ler.	Side wh'ler.	Side wheeler.	Side wh'ler.	Side wheeler.	Side wheeler.	Single Screw.	Single Screw.	Twin Screw.	Side wheeler	Twin Screw.
Type of Engines	Vert. beam.	Vert. beam.	Vert. beam.	Vert. beam.	Comp. beam.	Single Cy Vert. B.	Comp. In. Os.	Co'p.S.C Vert. B'm	4 cyl. d'le In. tr. ex.	4 cyl. trip. ex.	4 cyl. trip ex	Triple Expa'n	4 cyl d'le Comp in	Triple Expa'n
Diameter of Cylinders		90″	80″	90″	64″-84″ x x	110″	56½″-104″	75″x108″	47″ 75″ 81½″-81½″	28″-45″ 51″-51″	28″-45″ 51″-51″	24″-38″ 60″	51″-51″ 95″-95″	26″-40″ 64″
Stroke		168″	144″	144″	84″ 144″	168″	121″	110″x168″	90″	42″	42″	30″	132″	36″
I. H. P.—Maximum	2800	2500	2200	3500	4000	5300	5000	7500	5500	3000	3000	4250	9800	4800
Speed—Maximum	16	17	17	18	17.3	18.5	18.5	21	19.5	19.3	19.3	21.5	21 8	23.4
Cooling Surface in Condensers		5753	6000	7170′	6500		12,139′	15,000′	9050	4776	4776	6480′	16,000	6780′
Type of Propeller	—		—	—	—	—	—	—	—	4 blades cast i'n	4 blades cast i'n.	4 blades cast i'n	—	4 blades M.br'ze
Propeller Diameter	—	—	—	—	—	—	—	—	—	13′6″	13′6″	10′6″	—	11′0″
Propeller Pitch	—	—	—	—	—	—	—	—	—	18′6″	18′6″	15′6″	—	16′8″
Blade Area of Each Wheel	—	—	—	—	—	—	—	—	—	60°′	60°′	42°′	—	47.52°′
Type of Paddle Wheels		St'p B't	Radial	St'p B't	Radial.		Feat'ng	Feath'ing	Feat'ring	—	—		Feat'ring	—
Diameter of Wheels		38′11″	36′	35′6″	34′	41′	28′	35′	30′	—	—	—	35′	—
Width of Buckets		6′	10′6″	11′0″	6′8″		13′	14′	13′3″	—	—	—	11′	—
Depth of Buckets		2′4″	2′	2′4″	2′4″		3′10″	5′	4″	—	—	—	5′	—
Number of Main Boilers		6 { 2 st'l 4 ir'n	2	4	5	12	6	8	8	4	4	6	10	6
Type of Main Boilers		Iron Scotch.	Return tubular	Red-field.	Steel Scotch.	Steel.	Steel gunb'at	Steel Redfield.	Steel Scotch.	Steel Scotch.	Steel Scotch	Steel Scotch.	Steel Scotch.	Steel Scotch.
Length of Boilers		2 12″8′x13′ 2 11′x12′6″ 2 11′x11′6″	24′	15′0″	3@20′ 2@10′		20′3″	(6) 18′1″ 2) 10′0″	13′1″	11′6″	11′6″	12′6″	14′0″	12′10″
Diameter of Boilers			13′	17′6″	12′0″		12′6″	(6) 15′2″ 2) 14′0″	11′4″	13′6″	13′6″	13′0″	14′0″	13′6″
Number of Furnaces		18	6	8	16		18		16	12	12	18	30	18
Grate Surface		472	260	472′	390′		475	850′		274′	274′	390′	850′	450′
Heating Surface		7023	5000	13,675	12,480		14,250	25,500		7780	7780	11,500′	34,700	15,100′
Working Pressure		35 lbs.	40 lbs.	52 lbs	100 lbs.	50 lbs.	120 lbs.	110 lbs.	160 lbs.	160 lbs.	160 lbs.	160 lbs.	M.150 lbs	165 lbs.

mission the Bath-built boat commenced to show her speed, and all the boats she has encountered have been left far astern. On October 9, 1894, the Norwich Line owners resolved to have the vessel make a great record-breaking trip, and accordingly she left her wharf at North River at 5.33 p. m. and was moored at her dock in New London at 11.05 p. m., having made the trip of 122 statute miles in 5 hours and 32 minutes,—by far the quickest trip ever made up the sound. Her average speed from wharf to wharf was 22.04 miles per hour, and in the open sound her maximum speed was 23.4 miles. The vessel will soon be fitted with manganese bronze wheels, which, being much lighter, and of more pitch, will no doubt increase her speed. The sound boats built from A. Cary Smith's designs have many interesting features. First of all, they are the only twin-screw vessels on the sound, and are fitted with powerful triple expansion engines. They have each six boilers, and, as only five are in use at the same time, each of the boilers is cleaned every six weeks. Again the Peck and Lowell, although magnificent vessels, are built as cheaply and as substantially as possible. Everything on board is sound and first-class, and the materials and workmanship are of the best. But very little money has been spent for unnecessary interior decorations. The main saloon of the Lowell looks very pretty, being finished in delicate tints, well and tastefully ornamented with gold leaf. The furnishings are of the best, and the vessel has a solid, substantial look throughout. Nevertheless her interior cannot compare with those of the artistic Priscilla and the other modern Fall River boats. The Priscilla, however, cost about three times as much as the Lowell.

Another great feature of the twin-screw vessels is their great carrying capacity and economical steaming. Both the Peck and Lowell



CONNECTICUT, 1889.

carry more freight and passengers, using much less coal, and at the same time show better speed, than any vessel of the old type. The C. H. Northan, of the New Haven Line, built prior to the Peck, has been known as a great carrier and fast boat, but the Peck, 15 ft. shorter, carries ten car-loads more freight, and saves 18 tons of coal, per round trip. The City of Lowell carries nearly 50 per cent. more freight and one hundred more passengers than the City of Worcester of the same line, and the Lowell, making better speed, consumes but 48 tons of coal per round trip, whereas the Worcester consumes 87 tons.

A great feature of the Lowell is that she cuts through the water cleanly, leaving no turbulent wave behind her, and causing no high bow wave, thus proving the efficiency of the model, and the nearly complete utilization of power.

All the modern Fall River Line boats are fitted with a double bottom; in a word, they are unsinkable. They are built on the longitudinal system, and have high freeboard, so as to float when a large number of their watertight compartments are filled with water. Numerous instances could be cited, showing the value and proving the efficiency of the double bottom, when properly fitted; and the Pilgrim, Puritan, and Plymouth would all have been sunk, had they not been so constructed. A vessel fitted with a double shell has to be more stiff and rigid than a vessel not so fitted, as both the larger framing and the inner skin tend to give more strength, especially longitudinally, and this tends to reduce the vibration to a minimum.

Another great feature of the double bottom is that water ballast can be carried when desired, and the vessel can always be stable and trimmed well. The screw boats on the sound have no double bottom. This is a great defect. If any accident happens to them, they are in great danger. They have but little fore and aft strength, and even their scantlings for transverse strength are very light; this accounts for the vibration on some of these vessels, at times so excessive.

The ideal vessel for sound passenger transportation would be designed as follows: (1) Length and proportions sufficient to allow for good lines for ecconomical propulsion, and capacity. Give the vessel a good rising floor and easy bilge, and what you lose in displacement you can gain by giving the vessel more beam than usual. (2) For vessels up to 6,000 or 6,500 h. p., the twin-screw mode of propulsion; above that power, three screws, on account of the light draft necessary. Engines to be of the vertical triple or quadruple expansion type, with excessive boiler power, so that each boiler can be in turn disconnected and cleaned. It is possible that water-tube boilers may be used, especially if quadruple expansion engines are adopted. (3) A double bottom the whole length, on the longitudinal system, with good sub-division. The hull built out to the shafting aft, and the deadwood cut away forward, giving a rounding, easy sweep to the stern. Give the vessel a neat, yacht-like sheer, and a rakish, smart appearance, and put on as many decks as stability will allow.

Almost every new steamboat built since steamboats began to ply on the sound has been called the *ne-plus-ultra.* It would be rash to say even now that the limit has been reached. It is certain, however, that well-managed transportation companies will endeavor to keep their boats fully up to the expectation of the public ; but that the public are at present satisfied by the magnificent floating palaces recently constructed is evidenced by the great number of passengers that use them in preference to railroad trains, which also have reached a degree of comfort and luxury never before attained.

PARKS, PARKWAYS AND PLEASURE-GROUNDS.

By Frederick Law Olmsted.

THE aggregation of men in great cities practically necessitates the common or public ownership, or control, of streets, sewers, water pipes, and pleasure-grounds. Municipal pleasure-grounds comprise all such public open spaces as are acquired and arranged for the purpose of providing favorable opportunities for healthful recreation in the open air. As there are many modes and means ot open-air recreation, so there are many kinds of public pleasure-grounds. The formal promenade or plaza is perhaps the simplest type. Broad gravel-ways well shaded by trees afford pleasant out-of-door halls where crowds may mingle in an easy social life, the value of which is better understood in Southern Europe and in Spanish America than in the United States. Agreeable and numerous open-air nurseries and playgrounds for small children present a more complex, but perhaps more necessary, type of public ground. Very few public open spaces suitably arranged for this special purpose are to be found in American cities, and yet it goes without saying that every crowded neighborhood ought to be provided with a place removed from the paved streets, in which mothers, babies, and small children may find opportunity to rest and sleep and play in the open air. Playgrounds for youths are needed, but these may be further removed from the crowded parts of towns. Public open-air gymnasia have proved valuable in Europe and in Boston. Public flower-gardens are sometimes provided, but these are luxuries, and ought to be opened at the public expense only after the more essential kinds of public grounds have been secured. Promenades, gardens, concert-grounds, out-door halls, nurseries, playgrounds, gymnasia, and gardens may, of course, be combined one with another, as opportunity offers. To properly fulfil their several functions none of them need take out more than a small space from the income-producing area of a town.

There remains another less obvious, but very valuable, source of refreshment for townspeople, which only considerable areas of open space can supply. The well-to-do people of all large towns seek in travel the recreation which comes from change of scene and contemplation of scenery. For those who cannot travel, free admission to the best scenery of their neighborhood is desirable. It is, indeed, necessary, if life is to be more than the meat. Cities are now grown so great that hours are consumed in gaining the "country," and, when the fields are reached, entrance is forbidden. Accordingly it becomes necessary to acquire, for the free use and enjoyment of all, such neighboring fields, woods, pond-sides, river-banks, valleys, or hills as may present, or may be made to present, fine scenery of one type or another. This providing of scenery calls for the separation of large bodies of land from the financially productive area of a town, county, or district; and, conversely, such setting apart of large areas is justifiable only when "scenery" is secured or made obtainable thereby.

Having thus made note of the main purposes of public pleasure-grounds, we pass now to consider (1) Government; (2) Sites and Boundaries; (3) General Plans or Designs; and (4) Construction.

PARK GOVERNMENT.

The providing and managing of reservations of scenery is the highest function and most difficult task of the commissioners or directors of park works. Public squares, gardens, playgrounds, and promenades may be well or badly constructed, but no questions are likely to arise in connection therewith which are beyond the comprehension of the ordinary man of affairs. If scenic parks, on the other hand, are to be well placed, well bounded, well arranged, and, above all, well preserved, the directors of the work need to be more than ordinary men. Real-estate dealers must necessarily be excluded from the management. Politicians, also, if the work is to run smoothly. The work is not purely executive, like the work of directing sewer-construction or street cleaning, which may best be done by single responsible chiefs. The direction of park works may probably best rest with a small body of cultivated men, public-spirited enough to serve without pay, who should regard themselves and be regarded as a board of trustees, and who, as such, should make it their first duty to hand down unharmed from one generation to the next the treasure of scenery which the city has placed in their care. Public libraries and public art museums are created and managed by boards of trustees. For similar reasons public parks should be similarly governed.

A landscape park requires, more than most works of men, continuity of management. Its perfecting is a slow process. Its directors must thoroughly apprehend the fact that the beauty of its landscape is all that justifies the existence of a large public open space in the midst, or even on the immediate borders, of a town; and they must see to it that each newly-appointed member of the governing body shall be grounded in this truth. Holding to the supreme value of fine scenery, they will take pains to subordinate every necessary construction, and to perfect the essence of the park, which is its landscape, before elaborating details or accessories, such as sculptured gates or gilded fountains, however appropriately or beautifully they may be designed. As trustees of park scenery, they will be especially watchful to prevent injury thereto from the intrusion of incongruous or obtrusive structures, statues, gardens (whether floral, botanic, or zoologic), speedways, or any other instruments of special modes of recreation, however desirable such may be in their proper place. If men can be found to thus serve cities as trustees of scenic or rural parks, they will assuredly be entirely competent to serve at the same time as providers and guardians of those smaller and more numerous urban spaces in which every means of recreation, excepting scenery, may best be provided.

PARK SITES AND BOUNDARIES.

It is much to be desired that newly-created park commissions should be provided at the beginning, by loan or otherwise, with a supply of money sufficient to meet the cost of all probably desirable lands. Purchases or seizures of land should be made as nearly contemporaneously as possible. Before making any purchases, ample time should, however, be taken for investigation, which should be directed both to the study of the scenery of the district in question and to a comparison of land values. The first problem usually is to choose from the lands sufficiently vacant or cheap to be considered (1) those reasonably accessible and moderately large tracts which are capable of presenting agreeable secluded scenery, and (2) those easily accessible or intervening small tracts which may most cheaply be adapted to serve as local playgrounds or the like. A visit and report from a professional park-designer will prove valuable, even at this earliest stage of operations. Grounds of the local playground class may safely be selected in accordance with considerations of cheapness and a reasonably equitable distribution, but the wise selection of even small landscape parks requires much careful study. It is desirable that a city's parks of this class should present scenery of differing types. It is desirable that the boundaries of each should be so placed as to include all essential elements of the local scenery and to produce the utmost possible seclusion and sense of indefinite extent, as well as to make it possible to build boundary roads or streets upon good lines and fair grades. Public grounds of every class are best bounded by streets; otherwise, there is no means of insuring the desirable fronting of buildings towards the public domain. In spite of a common popular prejudice to the contrary, it will generally be found that concave, rather than convex, portions of the earth's surface are to be preferred for park-sites. If the courses of brooks, streams, or rivers can be included in parks, or in strips of public land connecting park with park or park with town, several advantages will be secured at one stroke. The natural surface-drainage channels will be retained under public control where they belong: they will be surely defended from pollution; their banks will offer agreeable public promenades: while the adjacent boundary roads, one on either hand, will furnish the contiguous building land with an attractive frontage. Where such stream-including strips are broad enough to permit the opening of a distinctively pleasure drive entirely separate from the boundary roads, the ground should be classed as a park. Where the boundary roads are the only roads, the whole strip is properly called a parkway; and this name is retained even when the space between the boundary roads is reduced to lowest terms and becomes nothing more than a shaded green ribbon, devoted perhaps to the separate use of the otherwise dangerous electric cars. In other words, parkways, like parks, may be absolutely formal or strikingly picturesque, according to circumstances. Both will generally be formal when they occupy confined urban spaces bounded by dominating buildings. Both will generally become picturesque as soon as, or wherever, opportunity offers.

After adequate squares and playgrounds, two or three local landscape parks, and the most necessary connecting parkways shall have been provided, it may next be advisable to secure one or more large parks, or even one or more reservations of remoter and wilder lands. In a city of five hundred thousand inhabitants a park of five hundred acres, however judiciously located, is soon so much frequented as necessarily to lose much of its rurality; in other words, much of its special power to refresh and charm. The necessarily broad roads, the numerous footways, the swarms of carriages and people, all call to mind the town, and in a measure offset the good effect of the park scenery. It is then that it becomes advisable to go still further afield, in order to acquire and hold in reserve additional domains of scenery, such as Boston has lately acquired in the Blue Hills and the Middlesex Fells. In selecting such domains, however, no new principles come into play. As in selecting sites for parks, so here it is always to be borne in mind that provision and preservation of scenery is the purpose held in view, and that demarcation of acquired lands is to be determined accordingly.

PARK PLANS OR DESIGNS.

To "plan" something means to devise ways of effecting some particular purpose. It has not always been thought necessary to "plan" the various kinds of pleasure-grounds. With no consistent end or purpose in mind, the members of some park commissions attempt to direct from day to day and from year to year such "improvements" as they may from time to time decide upon. That the results of this method of procedure are confused, inadequate, and unimpressive is not to be wondered at.

In order to be able to devise a consistent plan, such as may be followed during a long period of years with surety that the result will be both useful and beautiful, it is necessary, in the first place, to define as accurately as possible the ends or purposes to be achieved. As already remarked, these ends or purposes are as numerous as are the various modes of recreation in the open air. Thus a small tract of harborside land at the North End of Boston has been acquired by the park commission, in order to supply the inhabitants of a poor and crowded quarter with a pleasant resting-place overlooking the water, and with opportunities for boating and bathing. Accordingly, the plan provides a formal elevated stone terrace, connecting by a bridge spanning an intervening traffic-street with a double decked pleasure-pier, which in turn forms a breakwater enclosing a little port, the shore of which will be a bathing beach. In the adjacent city of Cambridge a rectangular, level, and street-bounded open space has been ordered to be arranged to serve as a general meeting-place or promenade, a concert-ground, a boys' playground, and an out-door nursery. Accordingly, the adopted plan suggests a centrally-placed building which will serve as a shelter from showers and as a house of public convenience, in which the boys will find lockers and the babies a room of their own, from which also the head keeper of the ground shall be able to command the whole scene. South of the house a broad, but shaded, gravel space will provide room for such crowds as may gather when the band plays on a platform attached to the veranda of the building. Beyond this concert-ground is placed the ball-field, which, because of the impossibility of maintaining good turf, will be of fine gravel firmly compacted. Surrounding the ball-ground and the whole public domain is a broad, formal, and shaded mall. At one end of the central building is found room for a shrub-surrounded playground and sand-court for babies and small children. At the other end of the house is a similarly secluded out-door gymnasium for girls. Lastly, between the administration house and the northern mall and street, there will be found an open lawn, shut off from the malls by banks of shrubbery and surrounded by a path with seats where mothers, nurses, and the public generally may find a pleasant resting-place.

Plans for those larger public domains in which scenery is the main object of pursuit need to be devised with similarly strict attention to the loftier purpose in view. The type of scenery to be preserved or created ought to be that which is developed naturally from the local circumstances of each case. Rocky or steep slopes suggest tangled thickets or forests. Smooth hollows of good soil hint at open or "park-like" scenery. Swamps and an abundant water-supply suggest ponds, pools, or lagoons. If distant views of regions outside the park are likely to be permanently attractive, the beauty thereof may be enhanced by supplying stronger foregrounds; and, conversely, all ugly or town-like surroundings ought, if possible, to be "planted out." The paths and roads of landscape parks are to be regarded simply as instruments by which the scenery is made accessible and enjoyable. They may not be needed at first, but, when the people visiting a park become so numerous that the trampling of their feet destroys the beauty of the ground cover, it becomes necessary to confine them to the use of chosen lines and spots. These lines ought obviously to be determined with careful reference to the most advantageous exhibition of the available scenery. The scenery also should be developed with reference to the views thereof to be obtained from these lines. This point may be illustrated by assuming the simplest possible case,—namely, that of a landscape park to be created upon a parallelogram of level prairie. To conceal the formality of the boundaries, as well as to shut out the view of surrounding buildings, an informal "border plantation" will be required. Within this irregular frame or screen the broader the unbroken meadow or field may be, the more restful and impressive will be the landscape. To obtain the broadest and finest views of this central meadow, as well as to avoid shattering its unity, roads and paths should obviously be placed near the edges of the framing woods. In the typical case a "circuit road" results. It is wholly impossible to frame rules for the planning of rural parks; local circumstances ought to guide and govern the designer in every case; but it may be remarked that there are few situations in which the principle of unity will not call for something, at least, of the "border plantation" and something of the "circuit road."

Within large rural parks economy sometimes demands that provision should be made for some of those modes of recreation which small spaces are capable of supplying. Special playgrounds for children, ball or tennis grounds, even formal arrangements such as are most suitable for concert-grounds and decorative gardens, may each and all find place within the rural park, provided they are so devised as not to conflict with or detract from the breadth and quietness of the general landscape. If boating can be provided, a suitable boating-house will be desirable; the same house will serve for the use of skaters in winter. In small parks economy of administration demands that one building should serve all purposes and supply accommodations for boating parties, skaters, tennis-players, ball-players, and all other visitors, as well as administrative offices. In large parks separate buildings serving as restaurants, boat-houses, bathing-houses, and the like may be allowable. It is most important, however, to remember that these buildings, like the roads and paths, are only subsidiary, though necessary, adjuncts to the park scenery; and, consequently, that they should not be placed or designed so as to be obtrusive or conspicuous. Large public buildings, such as museums, concert halls, schools, and the like, may best find place in town streets or squares. They may wisely perhaps be placed near, or facing upon, the park, but to place them within it is simply to defeat the highest service which the park can render the community. Large and conspicuous buildings, as well as statues and other monuments, are completely subversive of that rural quality of landscape the presentation and preservation of which is the one justifying purpose of the undertaking by a town of a large public park.

PARK CONSTRUCTION.

That the man who thinks out the general plan of a park ought to have daily supervision of the working-out of that plan is undoubtedly theoretically true. It is impossible to represent in drawings all the nice details of good work in grading and planting, and yet no work is more dependent for its effect upon finishing touches.

On the other hand, however desirable the constant oversight of the landscape architect may be, it is impracticable under modern conditions. The education of a designer of parks consumes so much time, strength, and money that no existing American park commission, unless it be that of New York, can as yet afford to engage the whole time of a competent man. Consequently, it is the usual practice for the landscape architect to present his design in the form of a drawing or drawings, and to supplement the drawings by occasional visits for conference with those in immediate charge, by descriptive reports, and by correspondence.

The prime requisite in the resident superintendent of park work is efficiency. Naturally enough, most of the superintendents of parks in the United States have been trained either as horticulturists or as engineers, but it is not necessary or even desirable that such should be the case. Probably the best results will be achieved by men who, possessing the organizing faculty and a realizing sense of the importance of their work, shall, with the assistance of an engineer and a plantsman, labor to execute faithfully designs which they thoroughly understand and approve.

Most men of specialized training, such as architects, engineers, and all grades of horticulturists, stand in need of an awakening before they are really competent to have to do with park work. Each has to learn that his building, his bridge or road, his tree or flower, which he has been accustomed to think of as an end in itself, is, in the park, only a means auxiliary and contributive to a larger end,—namely, the general landscape. It is hard for most gardeners to forego the use of plants which, however lovely or marvellous they may be as individuals, are only blots in landscape. It is hard for most engineers to conform their ideas of straightforward construction to a due regard for appearance and the preservation of the charm of scenery. Neatness of finish in slopes adjacent to roads is not sufficient; such slopes must be contrived so as to avoid formality and all likeness to railroad cuts or fills. Road lines and grades which may be practicable in the ordinary world are to be avoided in the park, because the pleasure of the visitor is the one object held in view. Roads, walls, bridges, water-supply, drainage, and grading,—such of these works as may be necessary are to be executed with all technical skill, as in the outer world; but the engineer in charge should be a man who will see to it that the work is done with constant regard to the object of a park as distinguished from the object of a city street or square or railroad.

Similarly, the park planter should be a man capable of holding fast to the idea that the value of a rural park consists in landscape, and not in gardening or the exhibition of specimen plants. Guided by this idea, he will avoid such absurd traces of formality as the too common practice of planting trees in rows beside curving driveways. In devising necessary plantations he will give preference to native plants, without avoiding exotics of kinds which blend easily. Thus, where a banana would be out of place, the equally foreign barberry, privet, or buckthorn may be admissible and useful. Influenced by the same principle, he will confine flower-gardening to the secluded garden, for which space may perhaps be found in some corner of the park.

If men can be found who will thus coöperate with park commissioners to the end that the lands and landscapes which the latter hold in trust shall be cared for and made available in strict accordance with that trust, excellent results can be hoped for in American parks. As before remarked, men who are capable of such work may certainly be trusted to construct and manage town spaces—squares, playgrounds, and the like—with due regard to their special purposes and to the satisfaction of all concerned.

THE ILLUMINATION OF STREETS AND PUBLIC PLACES.

By Franklin Leonard Pope.

IT is said that in England the essential distinction between a village and a hamlet resides in the fact that the former contains a church edifice, while the latter does not; but that, when a village, in addition to one or more churches, can also boast of a public market, it may aspire to the dignity of a town. In our own country it would not be far wrong to say that, when a neighborhood has become of sufficient importance, in the estimation of its inhabitants, to justify the provision of a sidewalk and two or three street-lamps by voluntary public subscription, it has advanced to the status of a village, while the introduction of gas or electric lighting in its streets and places of business surely ought to entitle it to the distinction of being called a town.

In a growing village the first essay in the direction of public lighting usually consists in the establishment of a number of kerosene lamps. These are commonly enclosed in glass lanterns or globes, and set upon wooden posts 8 or 9 ft. in height, erected near the sidewalks at each street-intersection or other convenient place, usually at intervals of 500 ft., more or less. There is a certain disposition, in these days of universal electricity, to underestimate the utility of kerosene as a municipal illuminant; but it is none the less true that, when properly installed and intelligently managed, it is capable of furnishing a really excellent service at a moderate expense. Lanterns are now so constructed that the enclosed lights are not materially affected even by violent winds and storms, while by the use of oil, wicks, and chimneys of the best quality, and by conscientious care in cleaning and trimming, results may be attained little, if any, inferior to those usually realized from gas and electricity.

One of the most serviceable types of street-lamps for burning kerosene embodies the principle of the well-known "hurricane lantern," and has a 1 ¼-in. wick. When properly trimmed, it will give a light of from 15 to 20 candles, with an average consumption of less than 1 gill of good oil per hour, the cost of which will scarcely exceed 2 mills. The cost of the lamps themselves, including either turned wooden posts or ornamental iron brackets for convenient attachment to buildings or trees, will usually not be more than $5 each, when in place.

In attempting to light a village with kerosene, a common mistake is that of installing too few lamps, and not placing them sufficiently high above the ground. A 60-ft. street cannot be well-lighted with lamps of this type, unless they are placed at intervals not much exceeding 250 ft. In built-up streets, having walks on both sides, the lamps should be situated between the walk and the roadway, alternating on opposite sides. In the central or business district, where the stores, churches, etc., are usually concentrated within a distance of a few hundred feet along the main thoroughfare, the interval between lamps may with advantage be reduced to about 125 ft. The lights should be at least 9 or 10 ft. above the level of the ground. In a country town of average compactness, it may safely be estimated that one lamp to each twenty-five inhabitants will suffice to provide a very satisfactory illumination of the thoroughfares, side-streets, and public places. The most economical and generally satisfactory plan of maintaining kerosene street-lights is to put the whole matter in the hands of a single responsible person, who should be able to clean, fill, and trim eight or ten lamps per hour, and to light twenty-five or thirty in an equal period of time. With a single assistant, starting an hour before sunset, one hundred lamps may be lighted before twilight. The cost of maintenance of course depends materially upon the number of hours the lamps are expected to burn in a year. If gaged to burn each night until after midnight, and left unlighted four or five moon-light nights in each month, according to the usual custom, perhaps 2000 hours per year may be taken as a fair average. This would consume about 40 gallons of oil, costing about $3; labor of filling and trimming, say $3 per year per lamp; renewals of chimneys, wicks, and other incidentals, say $1 more,—making a total of $7 per lamp per annum, which probably fairly represents the average cost in most village communities. With efficient and intelligent care, kerosene lamps may be made to light the streets, even of a large town, as brilliantly and effectively as by almost any known means, and at a comparatively modest expenditure.

For many years before the advent of electrical illumination the streets of nearly every municipality in the United States having five thousand or more inhabitants were lighted by gas. The burners most generally used were rated to consume 5 cu. ft. of gas per hour, and were assumed to give an illumination equal to 16 standard candles. At the time when the field of public lighting was first invaded by electric competition, the average price charged for gas for street-lamps was approximately $2 per thousand feet, equivalent to 1 cent per hour per lamp. Usually the gas company contracted to furnish everything, including labor of lighting and extinguishing, for a fixed sum per lamp, according to the schedule of hours of lighting agreed upon. A common price per year was $18 to $20 per lamp, on "moon schedule," or $25 to $30 for "all-night" lights. As a matter of fact, the street-lights under the gas *régime*, which in theory produced an illuminating effect of 16 candles, were too often in such a condition as to give not more than 10 or 12 candles, and the result as a whole scarcely compared favorably even with the kerosene lamp. A wide-spread dissatisfaction with the results of public gas-lighting existed in the community, which was often due, it is but fair to say, in no small degree to the absence of proper care and inspection on the part of the municipal authorities. This feeling of dissatisfaction had the effect of hastening the adoption of electricity for public lighting in many of the larger towns of the United States, within a very short period after the necessary apparatus had been placed upon the market in a commercial form.

Form of arc carbon tips. Current 45 volts and 10 amperes. (Full size.)

In medium-sized cities some use has been made of naphtha and gasoline lamps. These were introduced in the first instance as competitors of gas, having been found to give nearly as good illumination at considerably less cost. The general introduction of electricity, especially during the past 5 years, has largely diminished the use of devices of this character, and within a short time they will no doubt have completely disappeared.

The first attempt to illuminate a town by electricity was made at Wabash, Ind., in March, 1880. Arc lamps were used, two being placed upon the tower of the court-house and two more on a mast erected for the purpose. The trial run was witnessed by hundreds of visitors from all parts of the country. The plant, consisting of four lamps and the dynamo, is said to have originally cost $18,000. It was operated continuously for 6 years, after which it was taken down and ultimately sold for $30 as a historical curiosity. The first arc-lamps used, taking a current of about ten amperes, were denominated 2000-c. p. lamps; a meaningless and deceptive rating enormously in excess of their actual illuminating power, which, as recent investigations have shown, seldom exceeds one-fourth that amount. Although hundreds of thousands of arc-lamps have been used within the past 15 years for lighting the streets of American cities, they are by no means as well adapted to that purpose as their extensive use would lead one to suppose. A full-sized arc gives a brilliant and showy light, and a row of them imparts a decidedly metropolitan aspect to the streets of a small town or an ambitious suburban village; and it is perhaps for this, as much as any, reason that its popularity has always been greater than its intrinsic merit would seem to justify.

The light emitted by an arc-lamp is produced by the flow of the electric current across a space of $\frac{1}{16}$ in. maintained between the ends of two rods of hard carbon, these being fed forward as fast as consumed, by simple mechanism controlled by the current itself. Minute particles of highly-heated carbon are thrown off from the upper or positive carbon, until its end forms itself into a concavity termed the crater; and it is from the intensely hot surface of this crater, the total area of which is scarcely $\frac{1}{10}$ sq. in., that at least four-fifths of the total illumination proceeds. The actual "arc" is a little cloud of luminous carbon vapor, golden-yellow in color with an axis of violet, and emits most of the remaining light visible to a spectator standing below the horizontal plane of the lamp; the comparatively small volume emanating from the lower carbon being mostly thrown upwards against the hood or reflector. This explains the very uneven distribution of light from the electric arc. Directly beneath the lamp is always a circular dark shadow 30 or 40 ft. in diameter; encircling this is a zone of brilliant light, the maximum intensity of which is found at a horizontal distance from the vertical axis of the lamp equal to its height above the ground. Beyond this zone of maximum illumination the effective light rapidly diminishes, until at a distance of some 300 ft. it is merged in the surrounding darkness. The greater portion of the light from each arc is projected downwards, at an angle of some 45° with the horizon. This irregularity of distribution is for many reasons undesirable in practice. For example, it is well recognized as dangerous by horsemen to drive rapidly at night through a street lighted only by arcs suspended above the roadway at somewhat wide intervals. The alternate areas of intense light and opaque shadow, and more especially the blinding glare of the arcs themselves when viewed at certain angles, frequently render it impossible for either horse or driver to discern an obstruction until too late to prevent an accident.

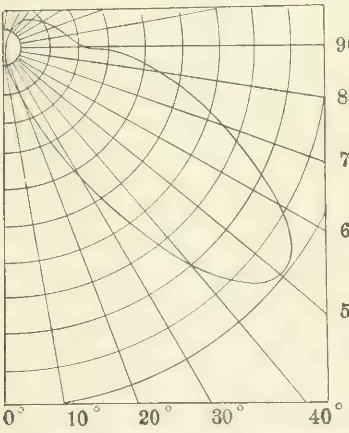
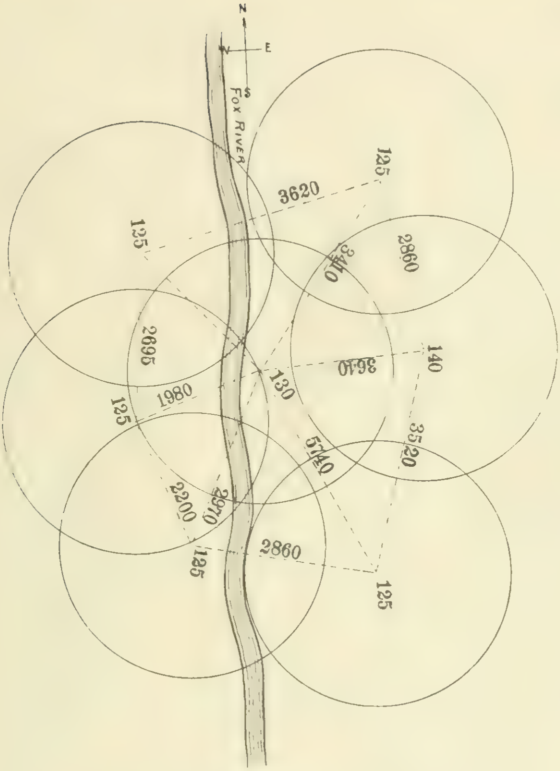


DIAGRAM SHOWING RELATIVE INTENSITIES OF LIGHT FROM DIRECT-CURRENT ELECTRIC ARC AT VARIOUS DEGREES OF INCLINATION TO THE HORIZON.

These objectionable peculiarities in the distribution of light from the electric arc early attracted the attention of electrical engineers, and led to a practice, at one time quite in favor, especially in western cities having broad streets with few high buildings or shade-trees, of grouping from four to eight arc-lamps in a corona upon the summit of a skel-



PLAN OF ARC LIGHTING BY TOWER SYSTEM IN ELGIN, ILL.

eton iron tower from 125 to 150 ft. in height, and providing the tower with an elevator by which an attendant could conveniently ascend to trim and adjust the lamps. As far as practicable, these towers were arranged at the intersections of a group of imaginary triangles, as many as five to seven towers being sometimes employed per square mile of area to be lighted. In a typical example of an installation of this kind, carried out some years since in Elgin, Ill., the central tower was 150 ft. high and carried five lamps; this was surrounded by six other towers, each 125 ft. in height and carrying four lamps. The towers were, roughly speaking, about half a mile apart. In this case the area lighted was about 4 sq. miles, and the population served about sixteen thousand. Such an arrangement, in a town adapted to its use, gives a very good distribution of light at a moderate expense, one of the marked advantages being the complete diffusion of the luminous rays, as made evident by the absence of the intensely black, sharply-defined shadows so noticeable when the lights are placed comparatively near the ground. For some years the tower system was in extensive use, but recently it has been largely superseded by other arrangements presently to be referred to.

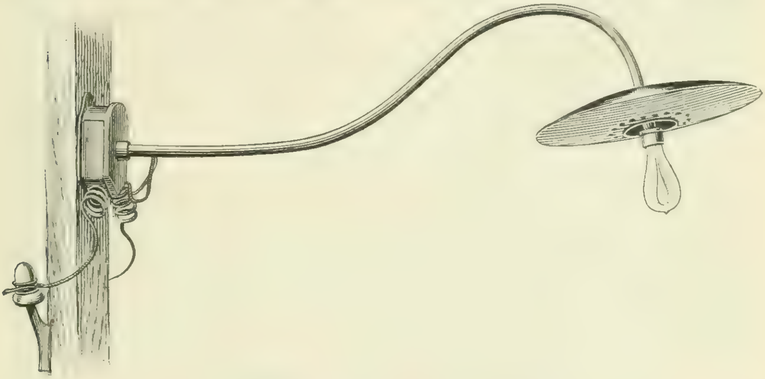
Perhaps the most satisfactory plan of installing the arc-lamp under the conditions ordinarily found in American cities and towns is to suspend it from a device known as a "mast-arm," placed on one of the corners at a street-intersection or other convenient location. A horizontal trussed iron arm is hinged to a bracket fixed to the top of an iron or wooden post. The lamp, with its protecting hood, hangs from the end of the cantilever about 20 or 25 ft. above the center of the roadway, and can be lowered to the ground, even when burning, for adjustment or recarboning. In streets more than 60 ft. in breadth the length of the mast-arm becomes somewhat inconvenient, and in such case recourse is usually had to a stranded steel cable, stretched diagonally across the street-intersection from supports placed at opposite corners, sustaining the lamp at a height of 30 to 35 ft. above the ground. The lamp may be lowered, when required, by means of a cord running through enclosed or "sleet-proof" pulleys.

The standard arc-lamp is designed to operate with a difference of potential between its terminals of 45 to 50 volts, and for effective work requires a current of 9.5 to 10 amperes, so that the energy actually expended in each arc is approximately six-tenths of a horse-power. Dynamos are now made of capacities ranging from 3 to 150 lights. The greater the capacity of the dynamo, and consequently the greater the number of lamps operated in one series, the less the horse-power required per lamp. It is usual, for instance, to allow 20 h. p. at the central station to supply 25 standard lamps, but 80 h. p. is sufficient to operate one of the new model 125-light machines.

A smaller type of lamp, known as the "half-arc," nominally of 1200 c. p., has found an extensive sale and introduction, especially in ambitious communities of an economical turn of mind. The electrical engineer finds it a somewhat difficult matter to discover where the economy comes in. The half-arc takes a current of 6.8 amperes at the same potential as the full arc, and hence nearly 50 per cent. more lamps may be fed from a dynamo and engine of equal cost and capacity than when the standard arc is used. The half-arc usually gives an unsatisfactory light; at all events, the falling off in luminosity is considerably greater than the proportionate saving of fuel at the central station. The original cost of the smaller lamp, as well as the expense of line-construction, inspection, and maintenance, is practically the same as in the case of the standard lamp. Of course a town can be lighted with half-arcs after a fashion at a considerably less initial cost of central-station plant than with full arcs, but it is difficult for the expert to conceive of any conditions under which the latter would not prove more satisfactory from the outset, and more economical in the long run, than the former could possibly be.

Recent investigations prove that the quality of the carbons used in arc-lighting has a far greater influence upon the quantity and quality of the light than had hitherto been suspected. With a given expenditure of energy, a difference of more than 50 per cent. in illuminating capacity was found to exist between different samples of commercial carbons purchased in open market and submitted to test.

Arc-lamps have been extensively operated, and with a fair degree of success, by means of the alternating current. They are frequently connected, two in series, across the terminals of a 110-volt circuit, such as is often employed in both direct- and alternating-current distribution, thus dispensing with the necessity of a special circuit or even a special dynamo. The practical objections to this type of lamp are, however, serious. Not only is its total yield of light for a given expenditure of energy one-fourth less in the aggregate than that of the direct-current lamp, but its distribution is such as to render it particularly unsuitable for street-lighting; it is thrown upward as well as downward, and requires carefully-arranged reflectors to obtain from it anything like a satisfactory illumination. The humming noise emitted by the alternating arc is peculiarly disagreeable, and in confined localities is sometimes very pronounced. All things considered, it does not at present appear probable that this type of lamp will ever find extensive acceptance in street-lighting as a substitute for the direct-current arc.



A STREET LAMP AND SHUNT BOX.

The question as to what is an equitable price for public arc-lighting is one which has unfortunately received a vast amount of unintelligent discussion, and many comparative figures, which, if not actually false, are at all events utterly misleading, have been circulated in the newspapers. An analysis of a large volume of trustworthy statistics from various sources and representing various conditions leads to the conclusion that for a plant of say one hundred standard arcs operated by steam-power, doing no commercial lighting, the actual cost per lamp cannot, at present prices, be brought much below $100 per annum

ELECTRIC LIGHT TOWER.

for the all-night schedule of 4000 hours, or $65 per annum for a partial schedule of say 2200 hours, even assuming the best modern appliances and the most careful management. Every person conversant with such matters is well aware that the figures frequently paraded in the newspapers, purporting to show that municipalities owning and operating their own plants have been able to furnish themselves with light at a cost materially less than that given above, are wholly untrustworthy. It may be safely affirmed that any municipality which is able to light its thoroughfares by contract with a private company at rates not more than 10 or 15 per cent. in advance of those given above has very little occasion to be dissatisfied with its bargain.

When the arc-lamp first began to be employed for public lighting, the incandescent lamp was still a thing of the future. Soon after the introduction of the latter into commercial use in 1880, some attempts were made to use it for street-lighting. The early incandescent lamps were, however, little, if any, superior in illuminating power to the gas-jets which they were intended to displace, while the cost of operation was materially greater; and, no doubt for this reason, it was several years before much progress was made in applying it to this purpose. Perhaps the first pronounced success in this direction was attained in a plant erected in Vincennes, Ind., in the autumn of 1886. One hundred incandescent lamps of 30 c. p. were placed at as many street-intersections in the suburbs of the city, and connected by a single wire in a series 11 miles in length. The dynamo was of the alternating type, and the system as a whole was characterized by great simplicity and effectiveness. The only important objection arose from the circumstance that the occasional breakage of the filament in one lamp would instantly extinguish all the remaining lamps in the same circuit, a difficulty soon surmounted by the ingenuity of different inventors who occupied themselves with the problem. An inductive resistance is now placed bridge-wise across the terminals of each lamp, and, upon the rupture of the lamp filament, it comes into play to maintain the integrity of the circuit. In this manner as many as sixty lamps are now successfully operated in a single series. The cost of poles, lamps, wiring, and fixtures in this system is comparatively small; in some cases not more than $6 or $7 per lamp, complete.

The very moderate cost, not only of installation, but of operation and maintenance, of the series incandescent system, will in all probability ultimately lead to its general adoption for public lighting in all except, possibly, the largest cities and towns. Under the conditions which are met with in most localities, experience indicates that the lamps should not be less than 20, and need not be more than 32, c. p. to combine economy and good distribution of light. In most cases a 25-candle lamp, if run at its full rated voltage, will be found to give excellent results. A plain, neat type of fixture often used, which is perhaps as good as any, is made of ¾-in. gas-pipe, curved into a goose-neck and screwed into a cast-iron socket upon the supporting pole. The lamp is set into a protecting sheet-metal hood and fitted with an annular convex reflector. Such lights ought to be located at intervals of from 250 to 300 ft., which in the central district of the town may with advantage be reduced to 125 ft. Along suburban roads lights 350 to 400 ft. apart will often serve the purpose sufficiently well. A fair contract price for supplying and operating 25-candle lamps in this manner for street-lighting would be from 1¼ to 1½ cents per hour, or say $20 to $24 per annum, when burned until midnight. Where cheap water-power is available, such lights have in some few instances been supplied by contract to municipalities at a rate as low as $16 per annum, but this could only be done at a profit under exceptionally favorable circumstances.

One very important advantage attending the use of the incandescent lamp for public lighting is that, with reasonably good management at the central station, it may be depended upon to give its full rated quota of light at all times and under all conditions of weather. Unlike the arc-light, it is affected by neither rain, snow, sleet, or wind. A 25-candle lamp will give in practice from twice to three times as much effective light as the average gas-lamp formerly found in the public streets of our cities and towns. Another advantage is that a one-wire line may be extended through the territory to be served in the most convenient way, and its terminals connected at any required points to the opposite feeders of any of the alternating systems now in general use. Such a line may be erected in a handsome village street in a manner so inconspicuous as to be quite unobjectionable from an æsthetic point of view. Slender, neat poles of wood or iron, painted to match the trunks of the trees, and carrying one or at most two lines of thin black-coated wire, may, by the exercise of reasonable care, be rendered so unobstrusive as to be scarcely apparent to the casual observer.

From the considerations which have been presented, it is apparent that the choice of a system of public lighting best adapted to the requirements of any particular municipality depends upon the conditions of the case. While it is probable that in the majority of instances the most uniform and evenly-distributed out-of-door illumination may be obtained by the series incandescent system, when judiciously laid out and installed, yet it cannot be denied that in places where it is desired to have the streets present a gay and brilliant appearance nothing can be more striking and effective than a liberal provision of standard arc-lamps, placed at a moderate elevation above the ground. Nevertheless, the humble kerosene lamp may in skilful hands be made to produce results which suffer but little in comparison with those derived from more pretentious sources.

ECONOMY IN RAILWAY OPERATION.*

(SECOND PAPER.)

By L. F. Loree.

WE have always poked more or less fun at our English cousins because of the difficulties they experience in handling the three classes into which they divide their passengers. Lardner said that in 1848 the third-class passengers constituted 42 per cent. of the total on the L. & N. W. In 1868 the companies began attaching third-class carriages to some important trains, and in 1872 to all trains. This was accompanied by a rapid increase in third-class travel, partly at the expense of the two other classes, so that in 1888 it constituted 80 per cent. of the business and is now estimated by Mr. Prout to be nearer 90 per cent. In 1875 the Midland reduced their difficulties by abolishing the second class.

The fact is that we in this country struggle with the same difficulties by giving our passengers special accommodation in sleeping, chair, and other special cars. These are used by not more than 10 per cent. of the passengers, and constitute a considerable item of expense,—one that will bear careful study. Much can also be done in decreasing car mileage.

Train mileage should be increased only after careful investigation of its necessity. It is probable that the business, as a whole, is not a source of profit to American lines. This condition is painfully aggravated by glaring evils, to which attention is constantly being called. Van Oss sums them up as free passes, rate-cutting, maintenance of the scalping system, superfluous agents, and injudicious advertising, and says that a large system should save $300,000 annually on its agents' roll, and that $16,000,000 annually might be saved to the roads of the country by abolishing the scalping offices.

The expenses incident to the handling of the trains constitute nearly one-half of the expense of operating the road, and, as Wellington has very well pointed out, until all has been done that can be done to reduce the number of trains required, it is hardly worth while to give a thought to reducing the expenses per train mile.

As the freight business constitutes approximately two-thirds of the total business and earns practically all the profits, it is naturally that which occupies the chief attention. The experience of my own divis-

---

*In the preceding paper under this title, on page 10 of the April number of this magazine, a table was given, entitled, "Average Miles per Locomotive per Month" The caption should have been "*per year*" instead of "*per month*"—a typographical mistake so obvious that it would probably mislead no one, but I prefer to thus definitely correct it. L. F. L.

ion is typical of the enormous reduction in the number of trains required to move the traffic, in consequence of the increase in locomotive and car capacity. In 1886 we began replacing our light 17″ × 24″ cylinder engines with heavy engines of the consolidation type, 20″ × 24″ cylinder. At the same time the cars were converted from a capacity of 15 and 20 tons to 25 and 30. The result was that, while the ton mileage of 1892 showed an increase of 75 per cent. over that of 1885, the increase in car mileage was only 16 per cent., and there was an actual decrease in the freight-engine mileage of .02 per cent. There is still a good deal of train mileage moved in this country with light engines. The last word has not been said in the matter of increasing the capacity of engines or cars, and we are likely in the future to reap substantial results from a further exploration of this field. I have heretofore expressed the opinion that much of the advantage gained through the heavier engine will be duplicated in reduced grades, and at practically the same cost.

Of vast importance, also, is the volume of traffic. Wellington points out that "12,000 to 14,000 miles of trunk lines make nearly one-half the earnings and carry far more than one-half the traffic of the country; the remaining 115,000 miles manage to live on the rest of it." It is upon additional tonnage that railroads grow rich. And few things have so potent an effect in reducing the expense per unit of traffic as additional tonnage, very few of the items of expense of operating being necessarily affected by it. At the present time, however, —and this is a necessity of panic times,—attention must be confined largely to the small economies of reducing the expenses per train mile. Let us despise not the day of small things, nor sneer at our efforts as "catch-penny methods" or "the small economies of the German method," for these have resulted in no inconsiderable saving. I think we may lay it down as a fundamental rule that *there must be no lost or repeated movements, but each movement must count economically by advancing the traffic in the direction in which it is earning money.* The heart of the transportation business is the station work. Upon the efficiency of those who do it depends the success of the subsequent movements. The clerical work should be carried on simultaneously with the handling of the goods, the side cards being attached to the car and the way-bills completed by the time the car is ready for its journey. Care should be taken to convey the goods direct from the wagon and weigh-scale to their place in the car; to stow the goods so as to avoid damage by breakage; to load the goods, if in a way-car, with reference to their removal; and to load the car as nearly as possible to its capacity. Not only does this last help to secure the minimum train mileage, but it effects further economy from the fact that such increase in the load does not proportionately increase the work done by the engine. There are few fields more fruitful of economic results than the loading and movement of cars. A keen eye should be kept on the cars belonging to foreign roads, in which nearly 40 per cent. of the business is handled. Unless the car has 3,000 lbs. of freight, it probably will not pay the mileage charges. Just as in the days of "wild-cat" banks the issue was taken to distant points to be put into circulation, so in times of light business some roads that cannot keep their cars profitably employed send them to distant points with insignificant loads in order that they may earn mileage. At the car accountants' convention of 1894 this knavery was fully canvassed, one road reporting as a sample a car from Vermont to a point in the far west, sealed and in bond to cross through Canada, containing one tub of butter. This led to the practice of carefully examining all foreign cars and passing them through a transfer-home for the consolidation of loads. In one day the contents of sixty-four cars were reloaded into fourteen cars. Besides the saving in train service, the avoidance of payment of mileage was a considerable economy. About $44,000,000 changes hands annually in settlement of mileage accounts, and this practically without check, each company being absolutely dependent upon the honesty of the other's returns. Each year at the car accountants' convention disclosures are made of "short mileage." It is hardly possible that so disgraceful a condition can long continue, and we find the car accountants following the recommendation of the English commission of 1867 by asking for the "charging for the car by time instead of by distance," thus making it possible for each road to demand an accounting for each of its cars for the 365 days of the year. This, however, is but a small part of the advantages of the change. With such a system the using road will no longer find it profitable to hold the cars of other lines idle for weeks, acting as agents in the solicitation of freight or as warehouses for the accommodation of shippers. Against the abuse of their equipment by the public, the roads have in a measure protected themselves by the collection of demurrage through car-service associations, and it hardly seems possible that they will long delay defending themselves against similar abuse by their competitors. Mr. Wheatley concludes that under the present system a car stands still four days for each day that it moves, and makes the low average mileage of 24.7 miles per day, a decrease of 22 per cent. between 1883 and 1892. Under improved conditions it is entirely practicable to increase this movement to 40 miles per day, enabling the traffic to be handled in 813,626 cars, saving $124,000,000 in the investment in equipment and $10,000,000 annually in maintenance. The cars, on being made up in trains, should be arranged in the order of the stations to which they are destined, the time wasted in switching on the road being very great. The engine should be loaded to its capacity. The method usually adopted is to rate the engine as capable of hauling so many cars, five empties being considered the equivalent of three loads. With the wide variations of weight of lading, this method on most lines does not secure the desired result. A method greatly advocated of late is to load the engine on a tonnage basis. The capacity of the engine on a level grade being ascertained by dynamometer test, its capacity on the ruling gradient is calculated. The light weight of the cars is taken from the stenciled markings on the car, and the weight of contents from data placed on the way-bills. These are then added together to determine the weight of the train, and cars added or cut off as necessary. The defect of this method is that it does not give consideration to the resistance offered by the car independent of its load. Nor do I find anywhere a determination of this resistance that is at once satisfactory and simple of application.

Munhall figures that in the merchant marine 20 per cent. of the sailings are in ballast. About one-third of the car mileage is made by empty cars. Every effort should be made to reduce this empty mileage, and, where cars run uniformly light in one direction, back lading should be actively canvassed for. A fruitful source of trouble is the fact that, while the traffic moves during the 24 hours of the day on most roads, the directing force, except the train dispatchers, work from 8 to 16 hours only. The office that distributes cars and power and controls the make-up of trains should never be closed. In discussions before the car accountants' association, it has been suggested that no car be moved without certainty as to its destination; that a daily inventory be taken of the cars on the line at some stated hour; that there be a comprehensive system of carding at terminal points; that the cars, whose numbers now run absurdly and awkwardly high, be renumbered, using prefix letters for the various classes of equipment and numbering from 1 up for each class; and that the joint inspection bureaus now coming into vogue be organized at all points of considerable interchange. In moving trains over the road, many duplicate movements may be avoided by a proper arrangement of sidings at stations, and by the adoption of "lap-sidings" at passing points.

Switching mileage (shunting) affects locomotive economy quite as unfavorably as empty mileage does car movement. It appears to furnish work for 28 per cent. of the engines in New York State and for 70 per cent. of the engines on the Lancashire and Yorkshire Railway. It is frequently possible to substitute gravity switching, which is much less destructive of equipment and quicker and more universal of application, and costs nothing to generate. Where possible, this should always be used. The cost can also be much reduced by building separate tracks for the switching movement, so that it may not be delayed or stopped by the road movement.

The expenses incident to injuries to passengers and freight do not exceed 1 per cent. of the total cost of operating. The loss on account of injuries to goods, which is about as $1.70 to $1.00 on account of injuries to passengers, has never attracted much public attention, though it is a source of intense irritation to shippers because of the delays with which most companies settle these accounts. This is aggravated by the fact that the really large sum thus expended is distributed in a great number of very small amounts. The claims of less than $30 constitute over 90 per cent. in number and about 33 per cent. in amount. But the matter of injuries to passengers is a cloud that, no larger than a man's hand at first, has come to cover the whole heavens. While the direct expense to the companies is small, the indirect expense, from installation of expensive appliances, increase in force, reduction in the capacity of the plant to handle business, and the increase in capital account, has been enormous. In almost every other item we have made rapid, and are now making slow, but continuous, reductions, but in this we seem to have discovered a field for the mushroom growth of increases. The safety of our operations are constantly and unfavorably compared with those of the English, and the community, press, and legislatures bring strong and constant pressure to make our practice duplicate theirs. Prout concludes that in the last 6 years the roads in the United States killed about four and a half times as many passengers as those in England relative to their train mileage. Jeans says that in that country in 1883 eleven people lost their lives by accidents to trains, rolling stock, etc.,—causes beyond their own control. Operating under our conditions, the inference is that fifty passengers would have been killed. They have, therefore, by their improved practice, saved the lives of thirty-nine passengers each year; but at what cost? The most important difference in practice is that the English work their traffic by the block system. Jeans estimates the cost of the installation of this system up to 1883 (the work began about 1872) as $43,000,000, or an addition of 1 per cent. to the capital account, and the wages of the additional men required or working the block signals and stations, together with the cost of maintenance, stores, interest on cost of plant, etc., as $11,250,000 per annum. That is, the English people are spending eleven and a quarter millions annually in this one item to save the lives of thirty-nine people, or $288,470 for each. Let us reflect that in the same year 293 people lost their lives on English railroads through trespassing,—lives that might have been saved by a proper exercise of the police power and without the cost of an additional dollar. Does not the result seem a trifle ridiculous when "compared to the massive battalions daily sacrificed in the conflict which mankind seems forever doomed to wage against intemperance, bad sewage, and worse ventilation." But, if the matter must be considered as one of high importance, it may well be inquired, in view of the experience of Massachusetts, New York, and Ohio, whether nearly as good results cannot be obtained at a fraction of the cost.

Personal injuries are usually divided into four classes. On a line of considerable importance, where the statistics are carefully kept, they bear the following proportions:

Class.	Percentage in number.	Percentage in amount paid in settlements.
Passengers	6.7	22.92
Travelers on highway	5.3	24.08
Employees	75.9	46.62
Trespassers	12.1	4.38

While the ratio of trespassers injured seems small, the injuries are usually fatal and represent about one-half of all the deaths. The disproportionately large number of injuries to employees is largely due to not separating the accidents happening to the men engaged in train movement from those happening to the men engaged in construction and repairs. Injuries to carpenters in falling from the roofs of houses are not uncommon: because a man happens to be on a railroad's maintenance-of-way rolls and is injured while repairing the roof of a station, it would hardly seem reasonable to classify it as a railroad accident. Mr. Barr finds that 32.6 per cent. of injuries to employees are due to hand brakes and link and pin couplers,—many being caused by the personal neglect of employees arising from familiarity with the dangers attaching to their occupation. The fact that Mr. L. S. Coffin, who perhaps has been as active as anyone in calling public attention to this source of danger, found it advisable at an early stage of his work to organize a Railroad Temperance Association, "the white button of which 100,000 practical railroad men put on in one short year from its inception," may indicate another prolific source of trouble. The more one studies this question, the more one is inclined to agree with the opinion expressed by With as long ago as 1852: "The number of these accidents depends upon the character of the employees; the seat of the evil is to be found here. I do not hesitate to repeat it even to weariness."

An analysis of train accidents which I have made with some care on my own division shows them to have been due to the following causes:

	Per cent.
Defect of road	16.22
Defect of equipment	20.94
Negligence in operating	50.68
Unforeseen obstruction	1.35
Malicious obstruction	0.67
Unexplained	10.14

One-half of the accidents appear to be directly attributable to negligence on the part of those engaged in the train movement. If we attribute also to negligence one-half of those accidents classed as defect of road and equipment and as unexplained,—as I think is not unjust,—then three-quarters of the train accidents flow from this cause.

The Miller Platform and Coupler began to come into use in 1863. The former has been much improved, and quite recently has received the further development of the Pullman Vestibule and Communication and Safety End Device. The latter, with the invention of Janney, has come to conventional lines under the moulding influence of the Master Car Builders' Association. The Westinghouse Continuous Brake, invented in 1869, is now in almost universal use on passenger equipment. The three have operated powerfully in reducing accidents to passenger trains. Under an act of congress the roads are required to replace automatic couplers and continuous brakes on their freight equipment by January 1, 1898. This entails an expenditure conservatively estimated at $40,000,000. The Inter-State Commerce Commission gives the following table of progress in this work:

	June 3, 1889	80,510
	" 3, 1890	115,319
	" 3, 1891	169,035
	" 3, 1892	244,334
	" 3, 1893	322,238
Unequipped	" 3, 1893	986,496

In handling so large a body of men as that employed in the railroad business great care must be taken in their selection, training, and organization. The force is probably under-officered, and is lamentably weak in the matter of inspectors. As was claimed in a recent report, "the army, which represents the acme of discipline, has, for a regiment of 1000 men, some 35 commissioned officers, and the officers are to look after 1000 men who are close together, virtually at all times under their eyes; while upon the railroad the same number of men would be controlled by certainly not more than 6 what we may call commissioned officers, yet the 1000 men on the railroad are scattered over 100 miles of territory, greatly increasing the difficulty of handling them," and their work is distributed over the entire 24 hours of every day. The salaries paid the officers are not sufficient to retain them permanently in the service, the younger men being constantly drawn away by street railways, large manufacturing plants, mining companies, etc. Unfortunately the rewards are too few, the promotions too slow, to excite the best efforts of the thousands employed. How much greater, then, the obligation to distribute them with justice,—an obligation too often ignored!

As to the men, I know of but three ways by which to improve them: (1) to get rid of such as are vicious, incompetent, or incapable of improvement; (2) in employing new men, to raise the average in character, education, and fitness; (3) to educate and train to a high degree of proficiency such as are retained in the service.

Generally the discipline is chargeable with favoritism, uncertainty, delays, too great severity or too frequent condonings, the reasons for which are not apparent on their face. Nowhere is the question of discipline so simple. The individual is brought into contact with too many persons to make it practicable for him to conceal the essential facts, and in the case of accidents the written history, the wreckage itself, tells the story to the trained eye. In fact, where the discipline is guided by a firm hand and one in which the men have confidence, the whole story is usually told by the men at fault with a straightforwardness which cannot be too highly praised.

But in this force, healthy and right-minded as a whole, is usually a small number of malcontents, vicious and irreclaimable. They ought to be vigorously hunted out and uprooted. But without much hunting the boiling-pot throws them to the surface. Then it should be remembered, as has been well said, that the exercise of virtue is often more dangerous than vice itself, because it is without the restraint of conscience. Probably in no other fields can greater evils grow so quickly from the drowning of justice by mercy.

No man should be employed unless he give references covering the five years immediately preceding his employment. A large part of the labor troubles of recent years have been caused by a class of men who tramp from one end of the country to the other,—"stake-men" who stay on one road only long enough to run up board bills which they do not pay, disappearing after a "pay-day drunk." For the troubles growing out of the continued employment of this class the railroads have only themselves to blame. Every man employed should be examined by a competent surgeon as to his physical fitness. The State now requires that men having to do with signals be examined as to their sight and hearing. There are many other defects, affecting safety or economy in operating, that should bar a man from the service. It would be a distinct gain to the country if the railroad force could be brought to as high a degree of physical perfection as the United States army has attained.

The tendency of late years has been not to take on employees under twenty-one. This seems to me an error; as an economical measure nothing can exceed the introduction of a reasonable number of young men of sixteen or seventeen as station employees, shop apprentices, telegraph operators, yard employees, and firemen. They are quick, industrious, easily moulded. Most of the men now controlling the details of operation started at that age. The country cannot afford to let "organized labor" degrade its youth by idleness or postpone their employment so late in life that their habits have become fixed, rendering them no longer teachable. The railroads at best have not the training faculty highly developed, and can ill afford unnecessary handicaps. In this, as in the employment of women, we can learn a useful lesson from the English lines. Of the 55,217 employees on the London & North Western only 130 are girls in the accounting department. "The railroad business," says Sir George Findlay, the general manager of that line, "is preëminently one requiring for its efficient conduct a high degree of smartness, alacrity, energy, and zeal on the part of every individual engaged in it." Nowhere, perhaps, can the dictum of Napoleon, "Let her attend to the distaff," be urged with greater force.

Besides the preliminary examination, the men should be examined periodically, with a view to instructing them in their duties, to terminating the engagements of such as are without promise, and to giving the better men some chance of overcoming the "rule of seniority" which is a prime cause of the lack of interest on the part of some of the men. Care should be taken to place the men in that division of the service to which they are best suited, and to keep in mind the necessity for personal contact with them to secure the best results. While the majority of men want to do their duty, their range of vision, from the nature of the business, is so narrow that they are unable to efficiently perform the work assigned to them unless very closely looked after by some one with a broader view and more liberal education.

There are certain forces outside the railway corporations which exercise more or less influence over them,—for instance, the labor unions. These organizations, copying closely the theories and methods of their English prototypes, are, if they may be judged from their written constitutions, of noble aim and high purpose, and exert influences of great good on their members, the railroads, and the community. Unfortunately, they have developed all the worst faults of the political "machine," and have fallen under the control of small cliques of active intriguers As Baker has pointed out, "We are now confronted by the fact that the wage-workers in the various trades of the country are engaged in exactly the same monopolistic schemes, and have exactly the same ends in view, as the monopolists who combine millions of dollars' worth of capital to effect their purpose. . . . . The monopoly formed by trades unions in the sale of labor is unnatural, because the number of competing units is great instead of small. As new competitors must continually arise, the monopoly can never be successful without the use of unlawful means." He shows from the census of 1880 that there are 14,744,821 persons engaged in occupations not monopolized to 5,647,368 engaged in occupations more or less monopolized, and concludes that trades unions do not exert any lasting influence on wages.

Buckle asserts that "to maintain order, to prevent the strong from oppressing the weak, and to adopt certain precautions respecting the public health, are the only services which any government can render to the interest of civilization." Fortunately governments in this country have displayed little disposition to interfere in the operations of railroads, and then usually only to correct some flagrant abuse. Beyond this they have "marred" rather than "made." In Ohio, for example, one legislature decreed that the height between the station platform and the lowest steps of the car should not exceed twelve inches. This may be a convenience to a few persons of excessive avoirdupois, but it entailed on the railroads of the State an expense of $75,000; led to the abolition of many flag stops where people had before been content to scramble up off the ballast, and who felt much convenienced thereby; and has been the means of preventing the establishment of new stops on the score of expense.

The railroad problems are formidable, and require time and much labor in their working out. They are not to be solved at a session of the legislature, and efforts at such solution of the questions of grade crossings, steam heat, block signalling, etc., are likely to prove a costly experience to the roads and the community.

A MARVEL OF MECHANICAL ACHIEVEMENT.

By Robert Perkins.

THE bicycle marks at this moment the utmost advance of inventive thought, and its construction crowns the highest pinnacle of mechanical achievement.

The foot of the panther, the wing of the eagle, and the rolling sphere,—these are the superlative models combined by the final art of man in a structure which, for lightness and strength, for carrying load and avoiding shock, is almost worthy to rank even with the creations of Nature herself.

The noiseless tread of the feline foot, the large thin tube and the edgewise strain-resistance of the aquiline wing, and the nearest known approach to that motion without change of the centre-of-gravity plane which belongs to the sphere rolling on a straight line,—these are the elements combined in the design of this matchless machine, whose construction employs to-day perhaps a hundred millions of capital in this country, and the finest and most ingenious machinery which American talent can create.

First a toy and then a whim, and then that least regretted of all departed things,—a toy and a whim dropped, discarded, and forgotten,—the bicycle had the living force of a vital seed dropped in the fertile soil of man's eager desire, and has risen from the dead not only to be the instrument of one of our grand divisions of out-door sport, but to enter seriously into the business and daily life and pleasures of civilized man in every division of the globe.

It is a strange story, this of the velocipede which died only to spring up again as the bicycle, into an all-pervading life after resurrection.

As a passing craze among those Athenians of America who seek every day some new thing, it crossed the ocean to England, and, when it had become so dead here that the very name was disgrace, and costly wheels could not be even given away, but were abandoned by their owners because of the odium which horse-owners had succeeded in bringing upon the velocipede, English muscle was rejoicing in a new field of wide-range exercise ; and so, after ten years of mouldering in the tomb of popular disapproval in America, during which the velocipede constantly grew in favor abroad, rechristened as the bicycle, the winged wheel crossed the ocean once more, this time to the westward, and the reign of the bicycle began in America with the "high" or "Ordinary" wheel. The high wheel had a well-made, comparatively light steel tubular frame, wire-spoke suspension wheels, and solid narrow rubber tires, which glided into public favor and large use so silently and quickly as to become a universal out-door presence while yet the non-using public was hardly aware of its return from improving travel abroad.

Lallement, the roving Frenchman, brought some parts of his crank-driven wheel with him when he crossed the ocean to the United States in the sixties. A blacksmith by trade and a genius by gift of God, Lallement had conceived the simple and impossible idea that a man supported on an unstable basis of two unfixed points could exercise the utmost power of the largest muscles of the human body without loss of balance, and believed that, by applying those muscles to turn a wheel of much larger radius than the crank on which the foot acted, a man could thereby increase the length of his stride, and so greatly enhance the rapidity of human translation from one place to another.

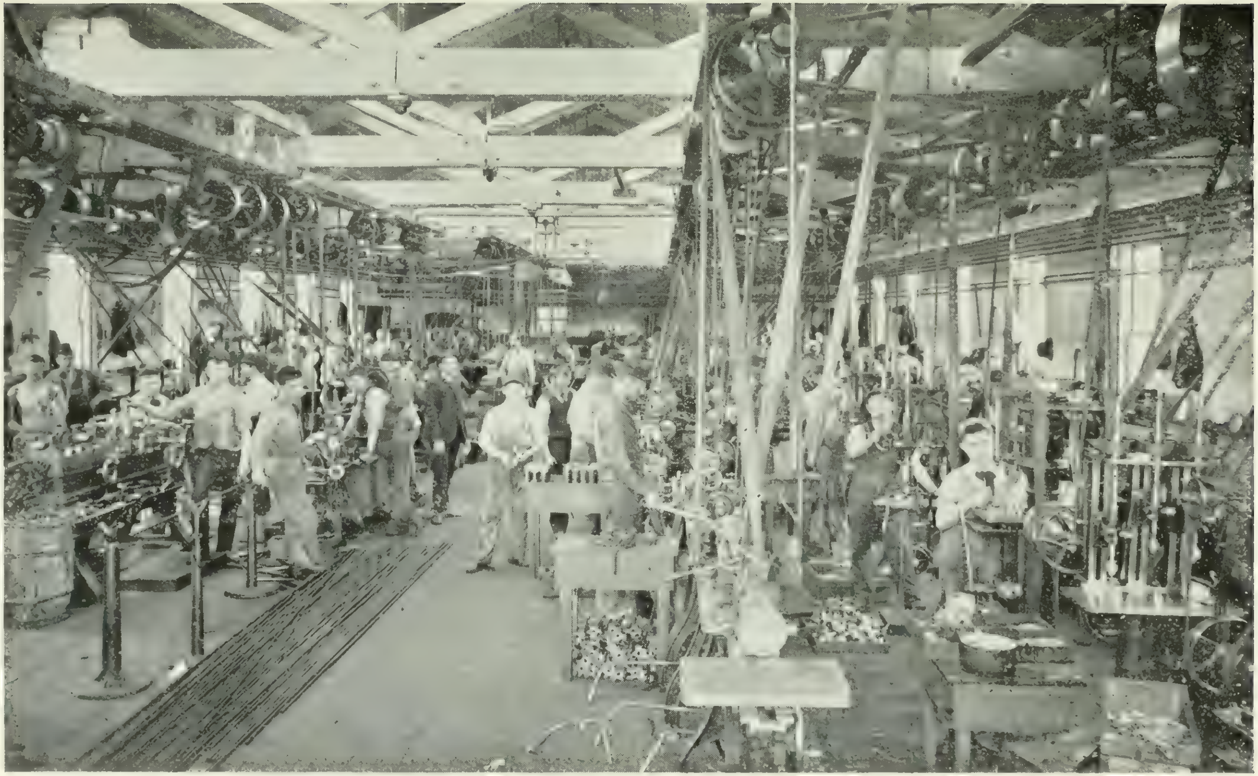
Genius is always right; it would not be genius else; and it is astonishing, when we look back along the line of successful march of an accepted invention, to note how exactly right in particular and detail the inspired madman was in his first conception of the new thing.

Lallement used two wheels of the same size, as shown in the illustration of his original machine which was photographed for use herewith, and equal wheels of 30, 36, 38, and 40 in. diameter, with wooden hubs and spokes and rims and steel tires, were the first constructions. The wire-spoke suspension wheel was known, and some elegant examples of all steel wheels were to be found among the velocipedes of 1869–70, which was about the date of the greatest first popularity of that horseman-maddening structure.

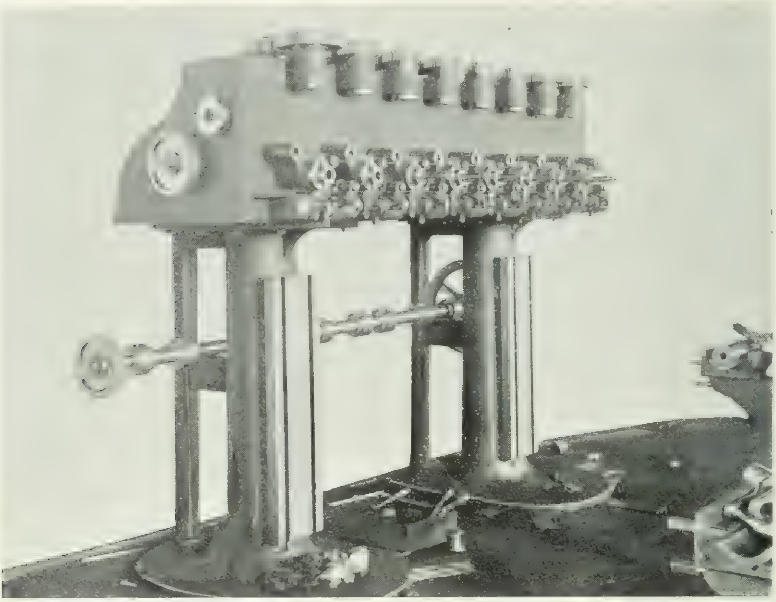
This low wheel brought the rider very near the ground, far lower than the occupant of our American carriage sits, and hence not only exposed him to the dust of horse-drawn vehicles, but made it an easy matter for him to be run down by enraged horse-drivers, or cut by a whip in the hands of some insulted owner of a trotter, annoyed at the ability of the despised rider of the despised machine to keep abreast of him, despite the best clip of his speedy roadster. This was the real reason of the hatred of the horse-driver for the old velocipede-rider. The horseman invariably lost his temper when the velocipede kept even with him or ran away from him, and soon open war was declared. Horsemen rode the velocipede down without scruple when able to catch the nimble usurpers of highway privileges with a shadow of excuse for the assault; speedy, skilful velocipede-riders ran persistently in front of magnificent turnouts, in a way to drive the horse-owners to distraction, and wilfully frightened timid horses by flashing across the roadway in front of the animal's blinders. The horsemen had the wealth and influence and were able to control legislation, and soon had the velocipede ruled off the park drives and sidewalks, leaving them only the streets and the footpaths of the parks. The rigid tire made riding on a rough paved street simply torture, and on a dusty suburban road—the only place left the despised velocipede where the rider could find pleasure—the velocipede carried the rider so near the earth that he was invariably a low, begrimed object, ridiculed by the carriage-riders and reduced in his own estimation by that sense of inferiority which belongs to low position and the consciousness of a begrimed face and dust-blackened linen. To avoid this low placing of the velocipede-rider, two western builders in '69 or '70 built large numbers of high or "Ordinary" wheels. Where the high wheel came from is not precisely known. There was a general tendency to make the rear wheel smaller than the front crank-driven wheel; Pickering, if memory serves correctly, made his wheels, in the old days, of about equal size, while the Demorest had a smaller rear wheel. There appeared in one of the west-side Chicago parks in '69 a high style of machine, with all-steel wire-spoke wheels, 60 in. in front and about 15 in. or 18 in. rear. This was among the first wheels of these proportions. It was built, owned, and ridden by a young machinist from Cleveland, whose name is unknown. Just at the close of the velocipede period of favor, Merrill Bros. of Beloit, Wis., and Crane Bros. of Chicago simultaneously decided that the velocipede had come to stay, and each firm made large numbers of wretchedly-constructed machines, with frames of gas pipe and malleable fittings, wooden wheels and steel tired rims. The Merrill was a high wheel in form. The Crane was between the Pickering and high wheel, with a rear wheel about half the front-wheel diameter. These machines would not hold together on the road for any length of time. The tapering threads where the pipes entered the fittings soon worked loose, the wheels gave out, and the whole thing went to ruin with amazing promptness. Long before Merrill or Crane sold out their stocks of wheels, the bottom dropped out of the sport, causing great loss to these builders, who had many hundreds, perhaps some thousands each, of these miserable machines left on their hands, to be finally sold to boys or whoever would buy at any price at all,—$15, $10, $5, or whatever was offered. This brought the velocipede into the hands of the very poorest boys and youths, and thoroughly killed the sport in the west, where it had great vogue for a while. The machines of Pickering and Demorest were well finished; the wheels were good; the frames were fine examples of smith work, made of light tubes welded together; and the finished machine was handsomely painted and silver- or nickel-plated, and cost from $75 or $80 for the cheapest up to $200 or $300 for the fancy finished vehicles. These prices kept the velocipede out of the hands of the poor at first,—except mechanics skilful enough to build good wheels for themselves,—and hence there was for a time some distinction in owning and riding a velocipede.

Rinks were established in all the principal towns of the north, and had a great patronage. The velocipede was a comparatively heavy and strong machine with an endurance up to really rough riding, and the regular rink floor equipment included inclined planes, flights of stairs, and jumps of various heights, and fancy rink-riding involved such work as would wreck the present bicycle in the first round. Trick riders and professionals came to the front, and were very expert, although at that time the now ordinary feat of riding the unicycle was debated as an improbable achievement. The future of the velocipede was in doubt, though the chances seemed in favor of its permanent popularity. Then came the determined and concerted action of the horsemen, followed quickly by municipal regulations which restricted the area of velocipede use to wholly undesirable localities, and the tide of public sentiment turned so that the solitary velocipede-rider was pretty sure to meet unpleasant events every time he took a spin on a public road ; and presently the whole art was in disgrace, and the velocipede was dropped—forever as it seemed—in the United States.

In England the conditions were quite different. The English highway is a smooth, dry, hard, well-cared-for surface, perfectly adapted to the use of the cycle. Beside the public roads, there are picturesque pathways winding past purling stream and violet bank and hawthorn bloom, all open to the narrow tread of the silent steed ; this matter of perfect roads and lovely bye-ways gave the bicycle-rider in England a vast range, freeing him from the necessity of intruding on the side walks or terrifying the nursemaids in the public parks. Another element of success for the bicycle in England lay in social distinctions, which are there so clearly defined that the patrician or horse-owning class did not deign to notice the goings-on of the mechanic in his outings. There were clashes, of course, between the wheel men and the horse men, but they were individual affairs, never rising to the dignity of class differences, and did not disturb the triumphantly victorious march of the cycle from its first position of an interesting novelty to that of a prime desirability for purposes of both sport and business. The cycle can test muscular endurance, and English muscular endurance loves to put itself under trial ; this national trait of love for athletic sport, and the national habit of good road-making, insured the prompt adoption of the bicycle by that vast class of English youth which could not aspire to the cost of horses, but yet had fifteen or twenty pounds and plenty of time to spare.



GENERAL MACHINE ROOM—ALL SMALL PARTS, HUBS, SPOKES, CONES, ETC.

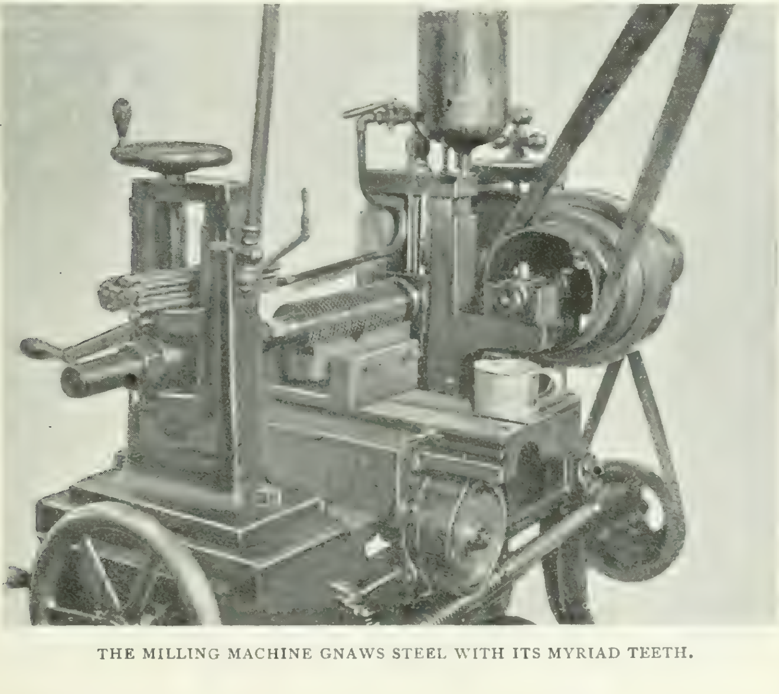


MASSIVE TOOLS IN CONSTRUCTION AT OUR FOREMOST SHOPS.

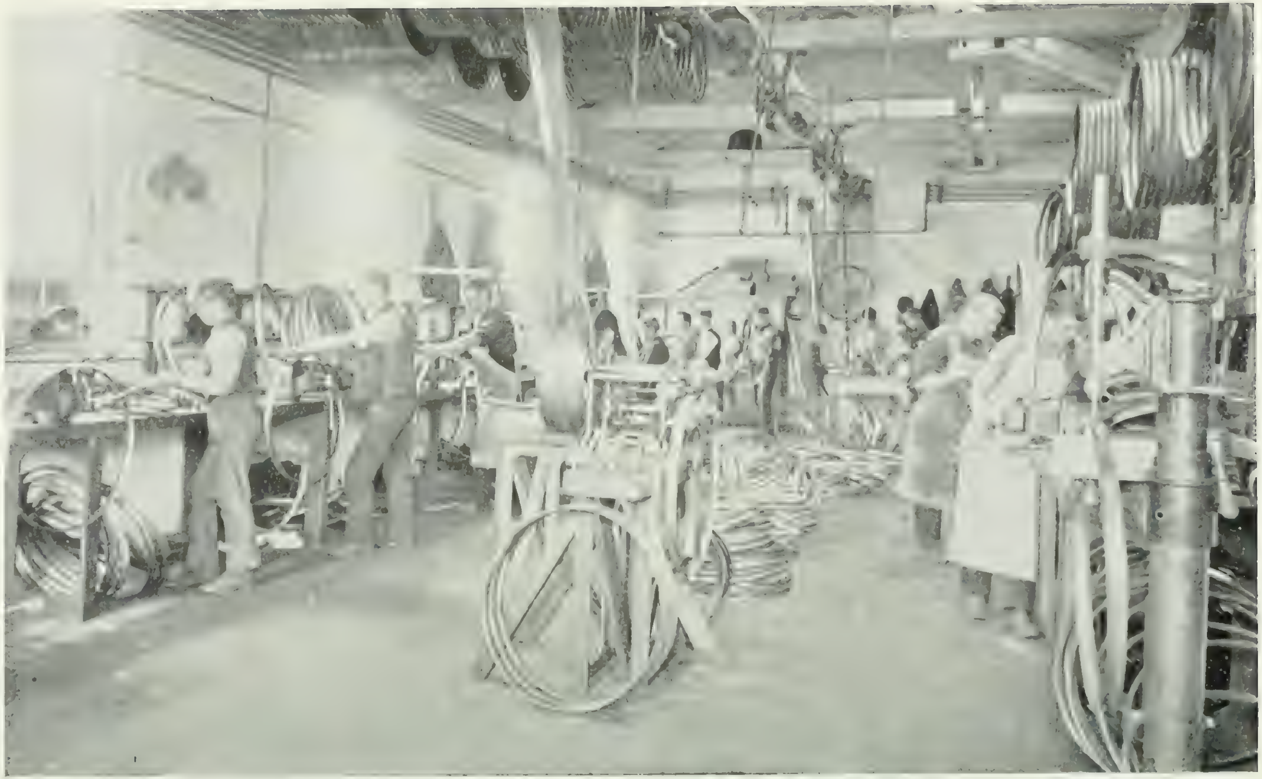
I first saw a bicycle in 1869 at Wood's establishment, Edgeware road, London. I bought one in 1870 of Driver Bros., Crescent road, Plumstead, London,—an Excelsior. It had a pair of 36-in. wheels; weight, 116 lbs. I put rubber tires on this machine in 1871; I had never seen a rubber tire on any machine, and hence can claim to be one of the original inventors of the soft tire. These tires were made of half round solid rubber cemented on the felloes. The tire was vulcanized together at the ends. I next built a machine in 1871 from lines of my own; weight, 75 lbs. This machine was borrowed for racing purposes, because of its lightness. It had a 38 in. front wheel and 12-in. rear wheel, with solid backbone and forks. I did some racing on this machine, with a personal record at the Bat and Ball Cricket Grounds, Gravesend, Kent, of 4.02.

The high or Ordinary front wheel was first put out in 1871 by Markaham, Edgeware road, London. About the same time Hyam of Wolverhampton, now in Washington, D. C., acting as agent for Humber, brought the first Ordinary to America. Hyam, who was a very expert trick rider,—the cleverest of his day,—introduced the high wheel in the United States with great approval. I saw the first unicycle in 1874, ridden by David Stanton, at Agricultural Hall, Islington, rider inside. Dan Canary, the most notable American trick rider, perhaps, who ever appeared in England, did veritable unicycle riding at the Crystal Palace, London, in 1886. At the last cycle show the Black Manufacturing Company exhibited in January, 1895, a machine weighing only 8¾ lbs. This machine was exhibited in January, 1895, and was called a freak by its makers. It was, however, a rideable machine, and would carry a 160-lb. or 180-lb. man on a floor. The lightest Ordinary I ever saw, 54″ × 16″, was exhibited by Harry James, of Birmingham, England, at the Stanley Bicycle club show in London, in January and February, 1890. This was a substantial machine, and was ridden on the floor day after day, although its total weight was only 11¼ lbs. Of cycles made at the present day, the lightest are racing machines. Extreme lightness leads to a great many repairs, and 24 or 25 lbs. is light enough for common use. My first regular connection with the manufacture of bicycles was in August, 1875, when I made a few machines on my own account,—"Ordinary" style solid rubber tire, of various sizes, 52″ × 16″ medium.

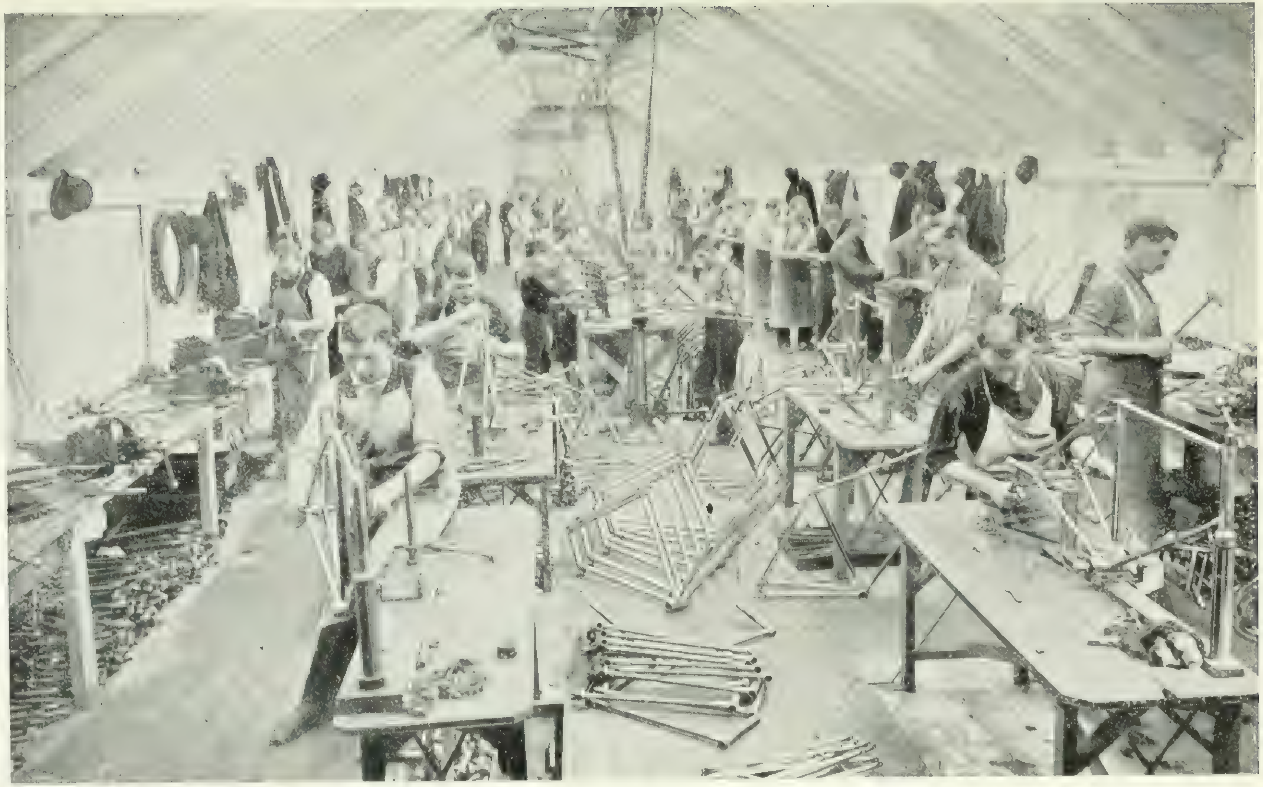
All the wheels up to this date and for some time after had steel rims. I first saw the pneumatic tire in 1889 at Booth's bicycle agency, Dublin. This tire was invented and patented by Dr John B. Dunlop, and was received with abundant ridicule as an absurd impossibility, but



THE MILLING MACHINE GNAWS STEEL WITH ITS MYRIAD TEETH.



RIM MAKING AND WHEEL BUILDING.

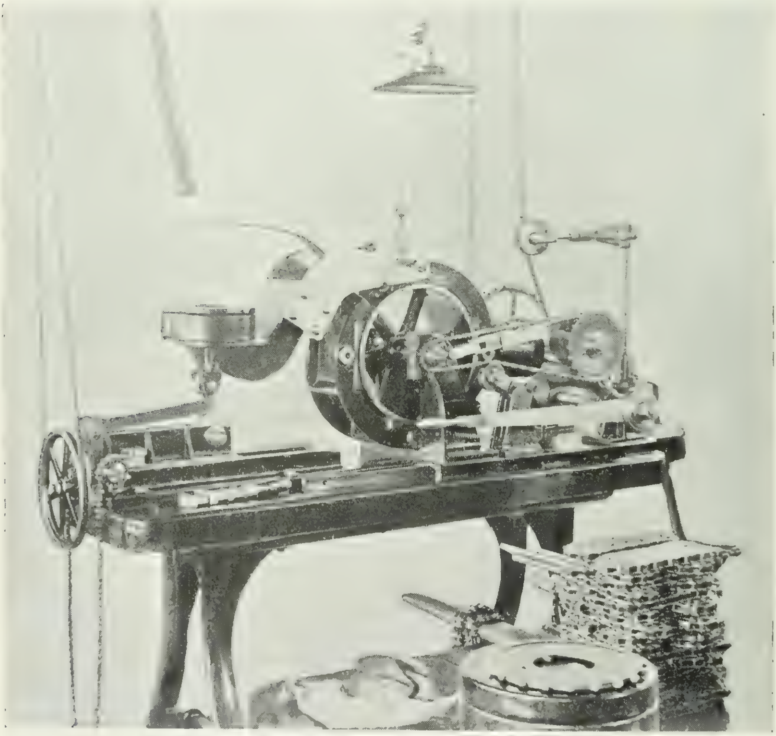


FRAME ROOM. BUILDING AND SETTING FRAMES AND FRONT FORKS.

it had faithful followers and a steady growth, which it constantly maintained until it reached its present exclusive use. Dr. Dunlop patented the pneumatic tire in England and America; the patent was not broadly for a pneumatic tire, but covered details which have since gone out of use. Dunlop's inventions have, however, kept pace with the state of the art, and he at present conducts large manufactories for pneumatic tires both in England and the United States.

The liability of the rider of the Ordinary to take unpleasant headers was very early recognized by all bicycle users, and the Star, which was a reversed Ordinary, having the small wheel in front, was devised, and had considerable use at one time.

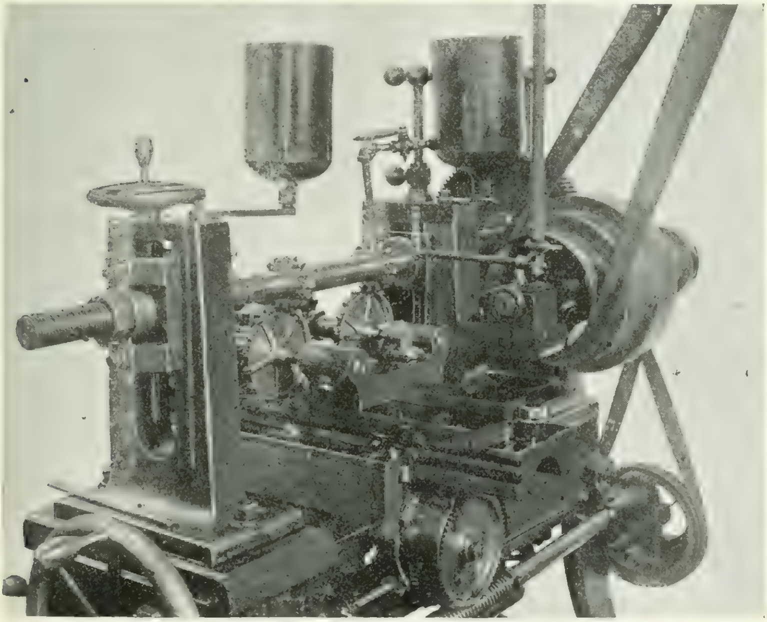
No really satisfactory solution of the problem of the header could, however, possibly be had with the high wheel. The rider sat high; a tumble was always possible; and the great distance of the rider from the ground often made the fall serious. To meet the situation, Mr. D. K. Sharley, of the firm of Sharley Bros., Coventry, England, designed the Kangaroo, which was an Ordinary cut down to wheels of 30 and



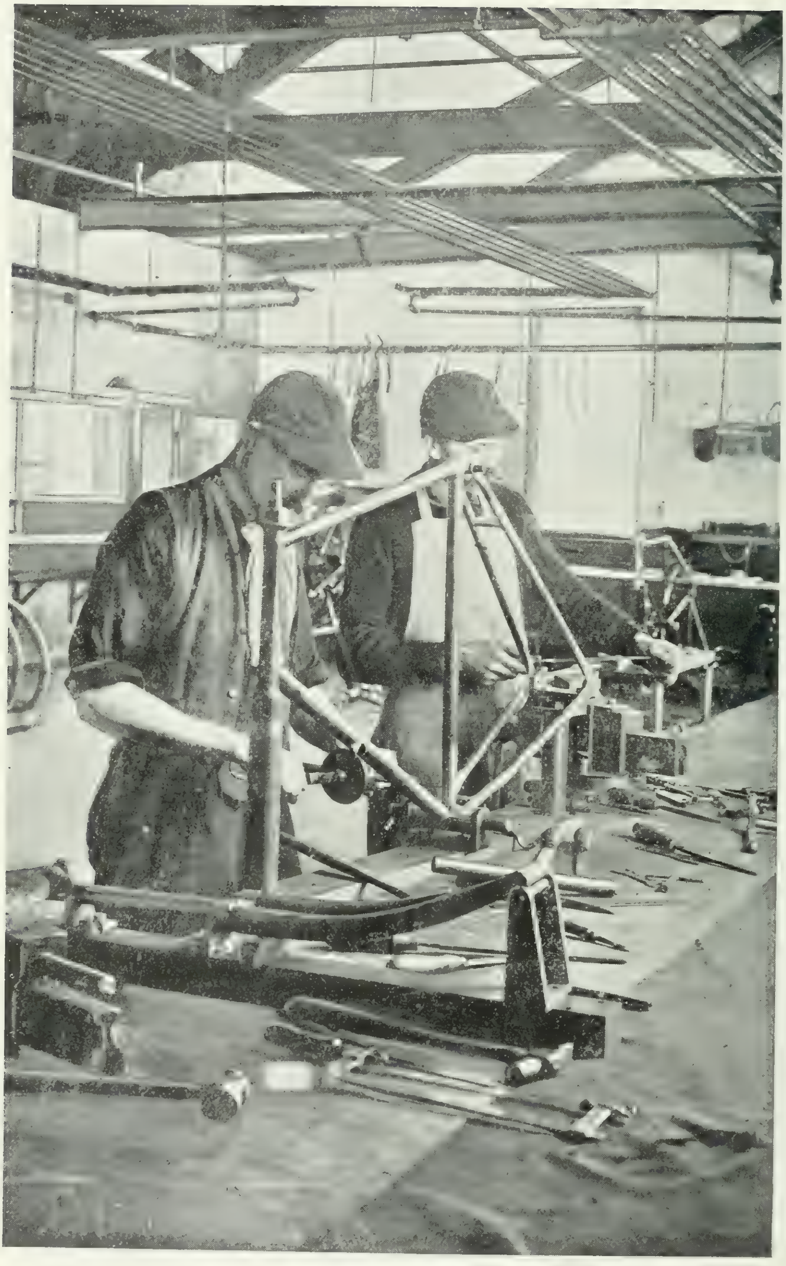
PRONY BRAKE CHAIN TESTING MACHINE.

NICKEL AND COPPER PLATING PLANT.

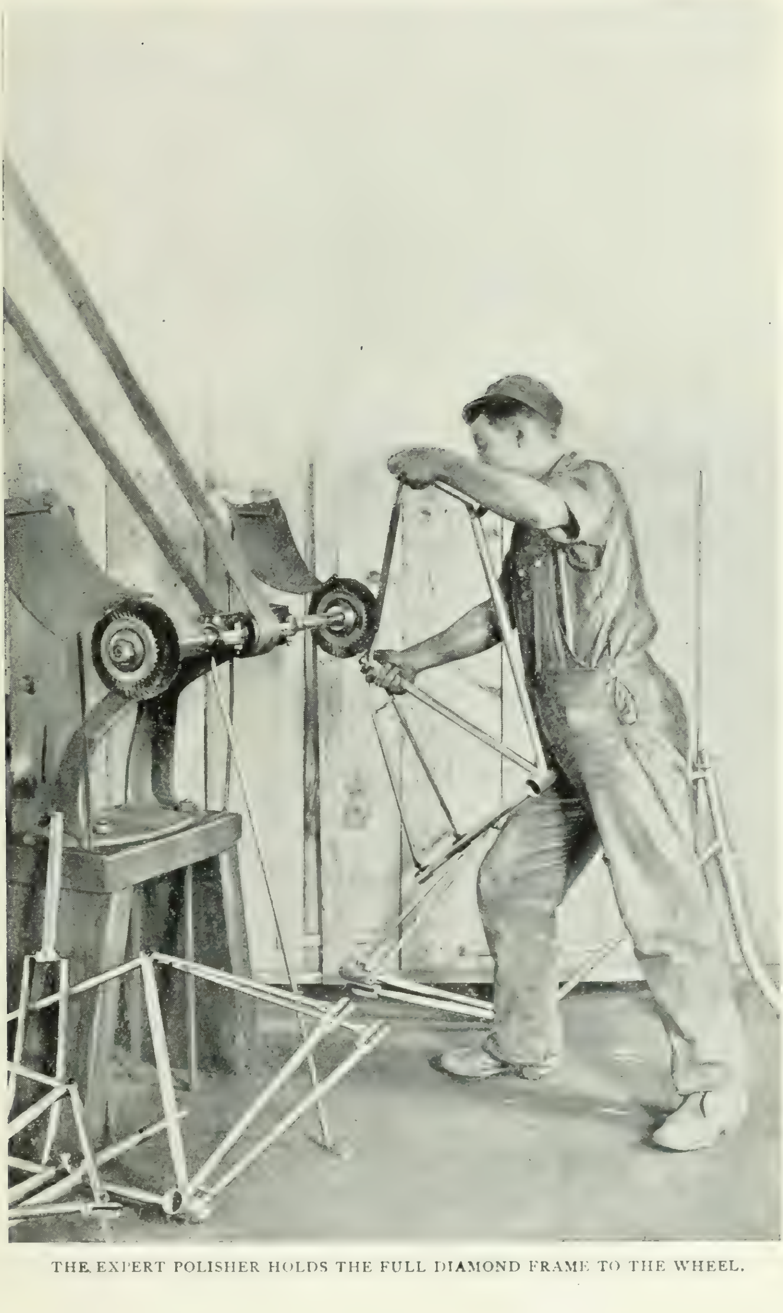
16 in. The Kangaroo had a diamond frame, independent crank shafts and was geared by two chains to the front wheel. It will thus be seen that the Kangaroo had features which have not, so far, been superseded, and which form the basis of our present practice. The



SHAPING THE RIMS OF THE CHAIN SPROCKET WHEELS.



CUNNINGLY DEVISED GIGS ARE USED FOR ASSEMBLING THE FRAME PARTS.



THE EXPERT POLISHER HOLDS THE FULL DIAMOND FRAME TO THE WHEEL.

A CORNER IN THE FORGE SHOP.

first Safety, named the Rover, was brought out by Sharley Bros. This wheel retained the independent crank shaft and introduced diamond frame, but was driven by a single chain from the crank shaft to the rear wheel, both the wheels being 30 in. in diameter. The weights of the Rover and Kangaroo were about the same, and both machines were very fast for the time and made new records. The Kangaroo had a considerable sale, but soon gave way to the Rover, which was the faster of the two, and gave the present Coventry cycle industry, which now employs about 15,000 hands in 40 workshops, its first decided impulse.

The first Safety, a Rover, was brought to America by Mr. L. Owens, now dealing in cycles at Washington, and was taken up very promptly by American makers, the firm of Smith Bros. of Washington being first in the field with the Dart Safety on the lines of the Rover. Thus both the Ordinary and the Safety found first root in America at Washington, which has, however, never had a very large bicycle factory.

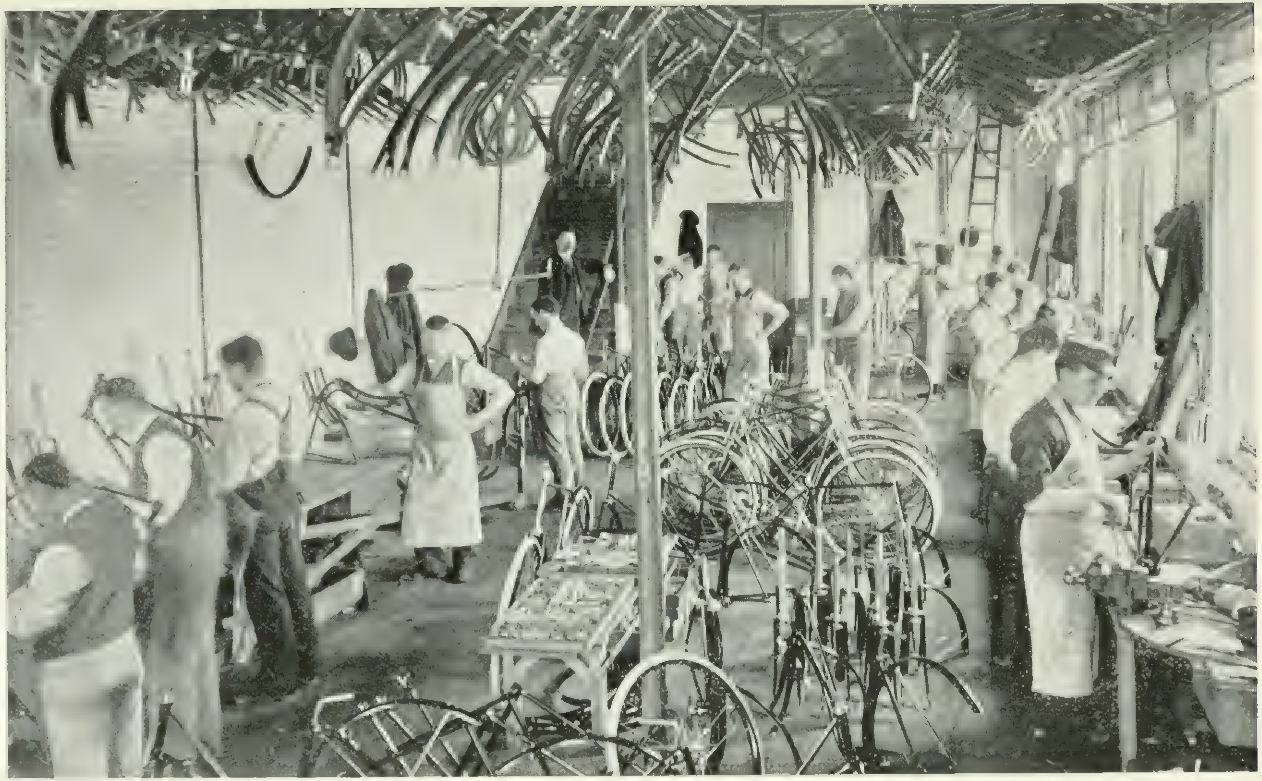
With the advent of the Safety, which came very nearly back to the Lallement diameters with its equal wheels, the possibility of the universal use of the cycle may be said to have fairly begun. The pneumatic tire, diamond frame of light steel tubes, ball bearing, and chain and sprocket wheel multiplying gear, were combined in the Safety, which lacked only the wooden wheel rim to contain all the elements of our present machines. Like all other finally-adopted details of construction, the wood rim met with great opposition. The steel rim had a tendency to "buckle," which is not present in the wood rim, and the wood rim is also much the stronger of the two, weight for weight, so that the wood-rim cycle is about 2 or 2¼ lbs. lighter than the steel wheel-rim machine.

The pneumatic tire is the greatest single improvement applied to the cycle. It was shown by the establishment of new records to be faster than anything else from the first; but its true theory was not generally understood, and it was not at first a fully recognized fact that, the more easily the tire yields, the faster it is. With a rigid tire, if the wheel meets an obstruction say ¼″ high, the wheel must lift that ¼″ bodily to surmount the obstacle; but, if the obstacle has a small surface, the pneumatic-tired wheel need not lift appreciably to pass over it; the obstacle sinks into the soft tire, and the wheel passes at the same level of motion it would have were the obstacle not present. The pneumatic tire thus saves a constant large rise-and-fall action of the cycle, and the softer the tire is, the less the rise for a given obstacle.

But before the present return in the safety form to Lallement's original wheel dimensions, the Ordinary or high machine had great vogue in the United States, commencing about 1880-81. It is largely probable that the old Lallement, Demorest, or Pickering form could never have come into use again in America. But the Ordinary carried its rider's head proudly above the common herd,—well above that of the carriage-rider, even; the enormous front wheel not only lifted the

DELICATE CHEMICAL TESTS OF MATERIAL ARE MADE.

POLISHING, BUFFING AND GRINDING.

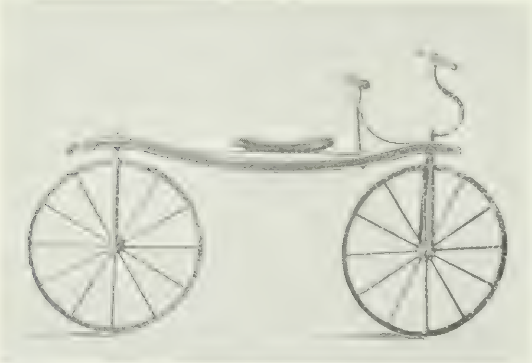


ASSEMBLING ROOM—ASSEMBLING FINISHED PARTS.

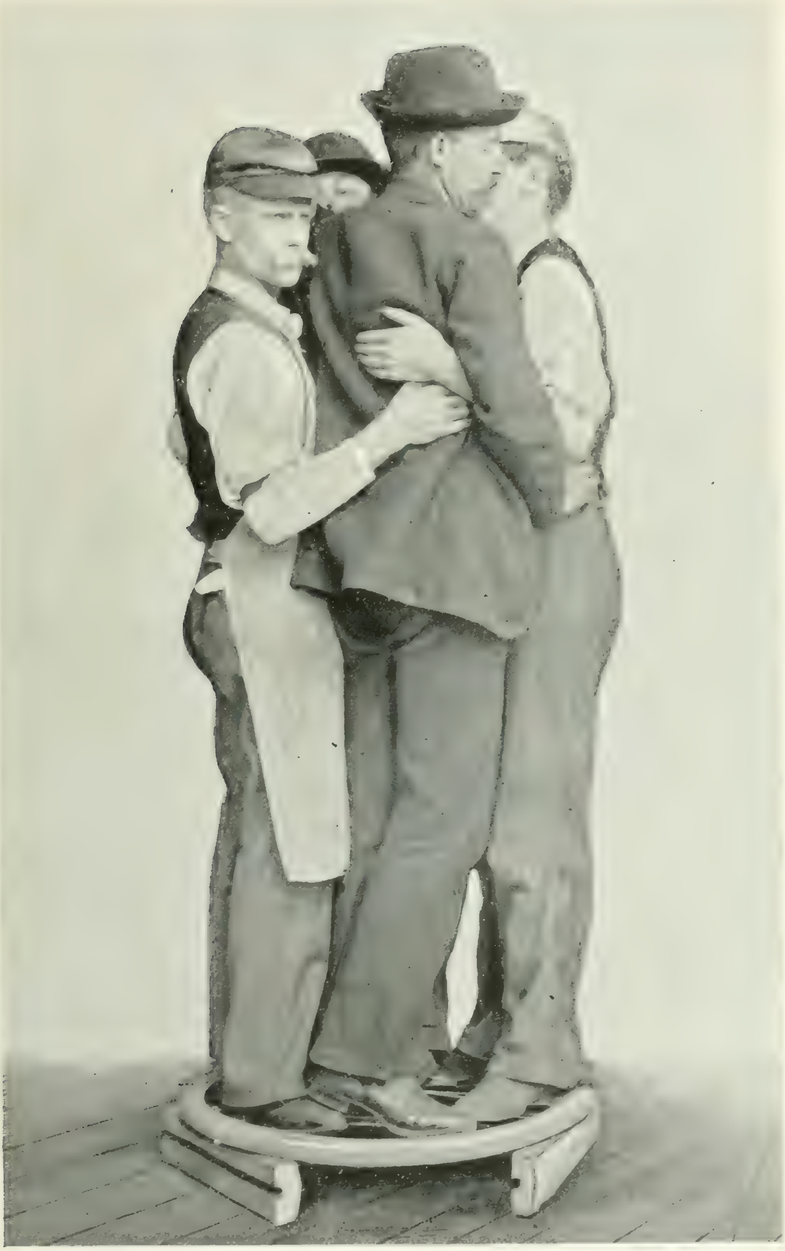
DEFT FINGERED GIRLS MANIPULATE PNEUMATIC TIRES.

rider out of the dirt, but gave him, at reasonably rapid travels, a slow and dignified muscular action which increased rather than lessened his self-respect, and brought the wheel into constantly increasing favor among American youth.

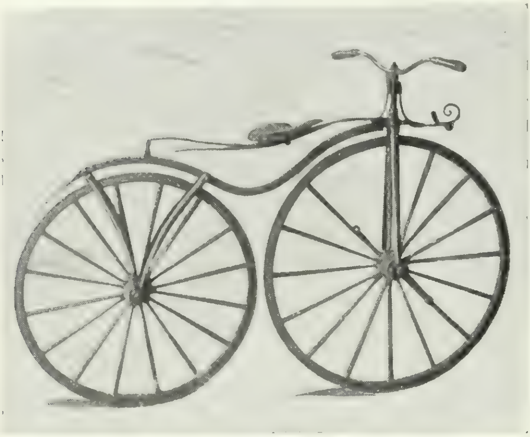
But while it is probable that the velocipede could never have been received under the new name of the bicycle without the use of the large wheel it is at the same time certain that the severe falls, the weight necessary to give usable strenght to the large wheel, and the general unhandiness of the ordinary style of machine made it impossible that the type should endure; hence, as soon as the mission of the high machine had been accomplished by reinstating the



THE FIRST, PROPELLED BY THE RIDER'S FOOT ON THE GROUND.



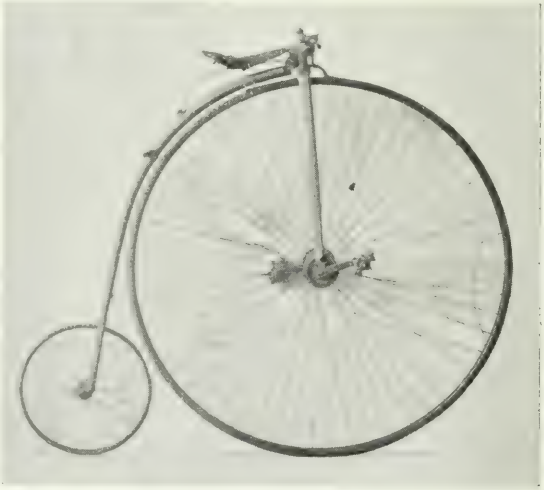
FOUR MEN CAN STAND ON THE SIDE OF THIS COBWEB WHEEL.



THE FIRST MACHINE EVER MADE WITH CRANKS.

bicycle in popular favor, its inherent faults at once drove the public back to the use of the small two equal wheels, geared to give the stride by making more than one revolution to one double stroke of the foot. Having brought the machine into favor with athletes and young men of outing tendencies, the high or Ordinary wheel was promptly displaced by the old Lallement form, which made its universal use possible.

From about 1881 or 1882 the revival of the cycle in the United States progressed with wonderful rapidity, and has never suffered any check. The hard times did not seem to affect the purchasers of bicycles, and the output for this season of 1895 is estimated at four hundred thousand, or about double that of any previous year for the United States. The importation of cycles is decreasing, and the exportation increasing. The American cycle is more largely machine-made than the European article, owing to the higher prices of American labor, and the well-known American aptness in devising special tools has been very largely exercised in applying wonderfully effective variations of the screw machine, milling machine, and drilling machine to the



THE HIGH COLUMBIA ON WHICH STEVENS RODE ROUND THE WORLD.

production of cycle parts. Appliances for brazing have also been largely developed and improved, and, in fact, every process employed in the production of the cycle has been brought to a point of wonderful excellence and low cost.

But the real miracle is the machine itself,—especially the wonderful strength and resistance of the wheels. It would seem absolutely impossible that a wheel 30 in. in diameter, with a wood rim and wire spokes so light that the whole structure weighs only 20 ounces, should sustain without permanent distortion the weight of four men standing on its side, with supports at four points only under the rim, and no hub support whatever, as shown in the illustration.

It also seems incredible that a cycle capable of carrying a man of 160 or 175 lbs. in weight can be made so light that the whole structure weighs less than 9 lbs. Yet this has been done ; even at the roadster weight of 22 or 24 lbs., the cycle carries a greater load with safety than has ever been put on any other vehicle.

The influence of the cycle on social life is already great, and will probably constantly extend, as it provides an out-door sport and amusement for women which did not previously exist in any form in America. American women are not walkers, but the cycle is perhaps even better suited to woman's use than man's, and seems destined to add an out-door element to the life of woman the world over which was not possible without the "winged wheel."

Our American cycle factories are now equipped with the finest plant which can be constructed, and are fully equal to the best armories, – or even superior, as they are the later construction ; and the magnitude of the operations and vast numbers of workmen employed warrant any expenditure which promises to cheapen the production or improve the product. But all this was inevitable. Granted the cycle and its great use, the vast cycle factories with their magnificent equipments, marvels of ingenious tool-making, and wonderful methods of construction, were certain to follow.

The miracle of the bicycle lies in its birth, death, and resurrection ; in its incredible load-bearing power in proportion to weight ; in its displacement of the horse as a means of pleasure ; and in the selection of its mechanical details of compressed-air support, tubular framing, and chain driving. All of these are details often before introduced in machines, but never before permanently retained. That these cast-offs are undeniable power-savers is convincingly proved by their continued use under human muscle-driving power.

Finally, the one great achievement of the bicycle is to increase the human powers of locomotion so that the slow-footed man is made one of the swiftest of all running creatures.

THE NEW SCIENCE OF ELECTRIC HEATING.

By W. S Hadaway, Jr.

HEAT is so closely allied to an adequate shelter in warming, and to food in cooking, that we must regard it from the practical standpoint of a prime necessity, and, in treating of its generation and distribution, base our deductions largely on whether the owner of a particular form of heating apparatus can operate it economically, and whether the user, or party to whom the heat energy is furnished, can employ it as cheaply as other forms of heat supply, with reasonable regard for collateral advantages. A heating system, to be an advance on existing methods, must be a source of wealth to the owner and a source of economy to the user.

A system of heat and electrical generation and transmission derives its value, largely, from the benefits of concentrated control, like other systems of public works. We are to regard heat agents as commodities which can be economically generated, transmitted, and applied. Electricity as a heat agent is not to be regarded as a source of heat, as that expression is generally understood, but, technically, as the high-potential heat factor in a telethermal system, where the heat secured is generated by simple resistance; or, we may employ electricity as an agent for producing available heat in operating a thermal engine by means of motors.

Of the fuel consumed under good steam boilers at least 65 per cent. of the heat energy is available for useful work. Steam in the best of steam engines theoretically possible can only transform 25 per cent. of the boiler energy into active mechanical work, and in practice 12½ per cent. is not generally exceeded. The engine work can be very economically transformed into electrical energy, in which form, considering it as heat, transmission losses are relatively small. In good steam and electrical practice the heat engineer can secure about 10 per cent. of the fuel energy in electricity, and of the balance of the fuel energy may write off 35 per cent. as direct loss and 55 per cent. as indirect loss. The indirect loss can be utilized with a properly arranged system of steam distribution over limited distances; and the combination of the electrical energy, available for heating purposes at varying temperatures, but usually above 212° F., and the exhaust steam, available for heating purposes at temperatures below 212° F., the writer has termed a multi-potential thermal system, in which electricity is employed as the high-potential heat factor and exhaust steam as the low-potential heat factor, and in which the heat energy is available for use in a telethermal system. That is, in practice, we have a system in which the ratio of high-potential heat to low-potential heat is about one to five, figured from thermal units and not temperatures, and in which the total fuel efficiency is about 50 per cent.

In domestic and industrial work we find two broad classes of heat control. The first class includes operations requiring diffused heat on a large scale, as in room and water heating, or heat of low potential and large quantity. The second class includes processes where heat is used at high temperatures and in small volume, as in cooking and laundry work and in many industrial operations, or heat of high potential and small quantity. A reasonable estimate of the relative thermal units employed in each class is found, after careful investigation, to be about five to one, assuming as a line of temperature demarcation 212° F. The average temperature differences between the two classes are not in the same ratio as the quantities, with this unit, but are sufficiently great to warrant a distinction between prices for heat energy at low potentials and at high potentials. What this difference in price should be can only be conjectured, but a fair rate of charge would seem to be not far from four or five times as much for high-potential heat as low-potential heat.

A practical illustration of the multi-potential heat system may be found in the requirements of a modern apartment-house in which there are several families, each with a kitchen and small laundry under the tenants' control, and with electric lights, steam heat, and hot-water supply, from a common source. The house equipment would consist of boilers, engines, dynamos, &c. The incandescent lamps, ovens, grills, flat-irons, &c., would be heated by electricity. The rooms and the water for bathing and culinary purposes would be heated mostly by exhaust steam. The owner would derive practically two profits from the fuel burned,—a direct revenue from heat supplied for cooking and laundry work, and an indirect revenue from utilizing the secondary products of the first.

In present practice the owner equips the house with gas ranges, which are a source of direct revenue, not to himself, but to the gas company. Electric lights, hot water, and steam heat are furnished by the owner, and figured as part of the rental value. The lights load is of so brief duration that the hot water and steam heat must come from live steam for a considerable part of the day. With a somewhat larger engine and dynamo, on the plan outlined, the live steam used would be largely supplanted by exhaust steam, on account of the larger load factor, besides providing a direct revenue to the owner to pay for fuel, labor, &c. The cost to the user of the electrical energy for cooking and laundry work at 4 cents per h. p. h. is not greater than gas at

$1.00 per thousand, provided all water-heating is omitted and the electrical apparatus fairly well controlled. The user or tenant secures a great number of collateral advantages, which represent the same advantages for less money or more advantages for the same money, and the owner may convert an expense into a revenue.

The illustration brings "electric heating" within our definition of an advance in heating systems, and shows a sufficient reason why the subject should receive the respectful attention of capitalists, property owners, and their architects. It also shows that the expression "electric heating" is an unfortunate one, as the problem is one for the heat engineer, in which steam and electrical engineering are elements, and in which the electricity used is the thermal equivalent of only about one-sixth the heat energy distributed and applied.

There is, to the writer's knowledge, no installation extant completely illustrating the multi-potential system of heating. The Yaryan installation of central-station hot-water heating at Toledo, O., described in *Heating and Ventilation* (Feb. 15, 1895), closely approaches it, and lacks only the application of electricity for cooking and laundering in the houses heated; and this installation is especially noteworthy in using water for thermal storage and circulation in connection with the exhaust steam-heat storage. In the *Electrical Engineer* (April 5, 1893) will be found a description of the Springfield (Ill.) Electric Light and Steam Distribution Plant. This installation approaches the hypothetical illustration closely enough to remove all reasonable doubt as to the strict accuracy of the deductions made for the multi-potential system.

In developing electric central stations the desirability of a large load factor is apparent. With full knowledge of the requirements in various cases, data on electric cooking and heating have been patiently and carefully collaborated. The result entirely confirms theoretical deductions as to the extent to which the station can provide at a profit the energy for cooking and heating. There is no doubt that the central station can furnish at a profit the high-potential factor in the thermal system. The question now rests as to whether the customer or householder will find a divided heat supply desirable. Of the six parts used, the electric central station can provide one-sixth, the high-temperature part, the customer himself burning coal, or gas, to furnish five-sixths of the heat. The electric central station can operate electrically-heated chafing-dishes, and pots for five-o'clock-teas (replacing the alcohol lamp); curling irons; plate-warmer in the pantry; laundry irons; small water-heater for nursery; bath, and dressing-room warmer, &c., and these specialties can all be made to increase revenue without adding materially to the construction account.

At a 5-cent rate per h. p. h. the devices enumerated are perfectly practicable; and other specialties, like shaving-mugs, toddy-heaters, egg-boilers, hot plates, &c., are coming into use. These are all of value as a source of revenue to the electric central station and of convenience to the users, but it must be doubted whether, with so small a percentage of residence lighting as is now connected, and with the inability to offer but a partial heat supply when connected, electric heating apparatus, in which the heat is derived from simple resistance, will entirely provide the balance in the load sought for.

To illustrate the capacity of an electric station as a heat-producer we may compare the prices charged by the New York Steam Co. and the Edison Electric Illuminating Co. of New York, both operating in the same district and supplying steam and electricity respectively. Using the figures given by Dr. C. E. Emery as the basis of charges for the Steam Co., we find that it furnishes heat to large consumers at 40 cents per 1000 kals, the kal being the equivalent of 1110 thermal units. For 40 cents 1,110,000 heat-units are supplied. Taking the Edison Co.'s rates, and using the 50 per cent. discount as the rate to a large user, 40 cents will purchase 8 h. p. h., or 20,518 thermal units. The ratio between the two is nearly 54 to 1; or, as a loss must be figured in the case of steam, dependent upon the temperature at which the condensed water is allowed to escape, practically 50 to 1. It would be unjust to leave the figures on the mere heat-equivalent of the two forms of energy, as high-potential heat energy is almost universally secured by localizing a small proportion of fuel energy and allowing the rest to escape, and is consequently worth more per heat-unit; but, even were we to admit as a reasonable charge five times as much for high-potential heat as for low-potential heat, the ratio is still 10 to 1, and indicates what might be accomplished could the two plants be run conjointly for a multi-potential heat supply.

Lord Kelvin, in an article "On the Economy of the Heating or Cooling of Buildings by means of Currents of Air," published in the Glasgow Philosophical Proceedings, Vol. III, December, 1852, and followed by mathematical demonstrations in the *Cambridge and Dublin Mathematical Journal* for November, 1853, has made some most interesting deductions.

"In the mathematical investigation it is shown that, according to the general principles of the dynamic theory of heat, any substance may be heated 30° above the atmospheric temperature by means of a properly-contrived machine driven by an agent spending not more than about one-thirty-fifth of the energy of the heat thus communicated; and that a corresponding machine, or the same machine worked backwards, may be employed to produce cooling effects, requiring about the same expenditure of energy in working it to cool the same substance through a similar range of temperature. When a body is heated by such means, about thirty-four thirty-fifths of the heat is drawn from surrounding objects and one-thirty-fifth is created by the action of the agent; and, when a body is cooled by the corresponding process, the whole heat abstracted from it, together with a quantity created by the agent, equal to about one-thirty-fifth of this amount, is given out to the surrounding objects."

In editing his "Mathematical and Physical Papers," Lord Kelvin added the following interesting note under date of June 26, 1881: "The method of cooling air in unlimited quantities described in this article has been realized by Mr. Coleman, first in refrigerators used for the distillation of paraffine, and, after that, in the Bell-Coleman refrigerator for carrying supplies of fresh meat from North America to Europe; in a great refrigerator recently sent out for the abattoir at Brisbane, Queensland, &c."

When Niagara is set to work for the benefit of North America through electric conductors, it will no doubt be largely employed for the warming of houses over a considerable part of Canada and the United States. But it is probable that it will also have applications, though less large, in other cold countries to multiply the heat of coal and other fuels, and to utilize wind and water powers (with the aid of accumulators) for warming houses.

The accomplishment of this form of heat control would enable us to construct uni-potential thermal systems, in whch the high-potential factor would be secured directly by the heat of resistance and the low-potential factor by employing electricity as agent to operate by a motor a device like that outlined by Lord Kelvin. A system of this sort would appear to largely increase the central-station load factor, and we would simultaneously introduce a large summer load by employing the same device, in reverse cycle, for cooling.

Of course many minor modifications of the two thermal systems outlined will suggest themselves. The gist of the whole matter is that for electric heating (or its synonym, central station heating) to be economical a multi-potential thermal system must be operated, which is entirely feasible over moderate distances; or, assuming that electric central stations are to continue to run with the present deplorable fuel economy, the second or uni-potential system is the only feasible one, considering the whole subject in its broadest sense, and remembering that, while the device to accomplish the results sought is shown to be theoretically possible, it has not yet been entirely developed.

Where a complete thermal system is to be constructed, with coal or low-cost carbonaceous materials as fuel, the multi-potential combination is the direct way to secure high fuel economy and profit to the owner and user; and where only the mechanical equivalent of heat is available, as from motors, water-powers, gas engines, &c., we must interpolate a device for diffused heat control to heat buildings, and water for use in same, in addition to the energy for high-temperature work, which we can profitably secure from direct heat of electrical resistance.

Results already accomplished in electric heating depend wholly upon the high-potential factors of the broad systems outlined. The time is not ripe for a comprehensive review of the collateral benefits derived from a highly localized form of heat energy, our concepts of the elasticity of which are only measurable by concepts of the rigidity of the ether. Instead of a concerted effort to create a field of use for the apparatus by constructing complete thermal systems, nearly all of the applications have been made as minor incidents in systems of electric lighting and power already established. This, of course, is logical pioneer work, but it fails to reach the vital elements necessary for full development.

The famous "Electrical-Heater Man" at the Franklin Institute in 1884 was the butt of the practical jokers among his co-exhibitors. The apparatus there shown was the first form of the electric car-heater, with which to-day upwards of five thousand cars are equipped. The status of the electric car-heater is peculiar; it cannot be regarded as an economical device, but rather as a public requirement. An electric car is too small and crowded to admit of an economical and efficient isolated system of heating. Again, very little actual heat is required under average conditions, but rather a small amount of sensible warmth, uniformly distributed to each passenger on the basis of individual effectiveness. This can be met by an electrically-heated radiant at an energy consumption of less than 100 watts per sq. ft. of surface, and, in the common 20-ft. car 20 sq. ft. of radiating surface are sufficient for average conditions, and 35 sq. ft. of radiating surface for extreme conditions.

Too little regard has been paid to the item of individual effectiveness in rendering cars comfortable. So much energy has been wastefully used in air warming, even under average conditions, as to render the power consumption a most serious matter. The result is to give an unjust impression as to the cost of making cars habitable by electric heaters, and in the case of elevated roads, using large cars in trains, the item is a still more important one, as the energy for heating may equal or exceed that for propulsion. Again, in the case of elevated roads there seem no good reasons why the small rooms in the stations along the line should not be heated by the same agency as the cars, and in economical work of this magnitude we appear to be forced back to the uni-potential system using electricity as agent.

In small cars the heat of resistance is not excessively expensive. As in the case of the Vaudeville Theatre installation in London, there are peculiar local conditions which, as practice has proven, can be satisfactorily met with resistance heaters. But, while under ordinary circumstances we can heat bath- and dressing-rooms in residences by resistance heaters quite cheaply, considering intermittent use, we would not attempt to heat the whole house by the same means. If electric roads would locate their stations contiguous to business blocks and utilize their exhaust steam for heating purposes, there would be no difficulty in meeting the requirements of car- and station-heating on a large scale by resistance heaters. The *Railroad Gazette* (March 22) has given some interesting figures on "The Cost of Heating Cars by Electricity," in which comparisons are made between heating large cars by electricity and by steam. As a general rule, the smaller the divisions of space and the more intermittent the use, the greater is the economy of electric heating ; and we may include in this rule water heating as well as space heating.

Cooking by electricity is an important part of electric heating. In practice it means the accomplishment of high-temperature processes by resistance heaters, using other sources of heat energy for the hot-water supply and, preferably, water-boiling processes, as in vegetable-cooking. One of the most complete analyses of this subject which has appeared was published in *Science* (Sept. 15, 1893). The deduction is made that electricity at about 11 cents per h. p. h. is as economical as the common coal-range for cooking, provided the electricity is used to heat an oven, the hot water being secured from outside sources. This appears to presuppose a radical change in cooking methods and apparatus, and, while this is undoubtedly proper in order to get best results, practice has seemed to require at the outset a more elastic system, in which the utensils conform to the generally accepted notions of what shapes and sizes should be.

To this end an experimental plant has been operated for 15 months in charge of a cook without special instructions as to the best method of operating the apparatus for economy, the desideratum being that good cooking shall be done and the utensil disconnected from the circuit when the cooking is completed. The equipment consisted of an oven, broiler, portable stoves, spider, plate-warmer, coffee-pot, and small tea-kettle. The result has shown that, with apparatus conforming generally to the accepted notions of cooking utensils, the cost of electric cooking is practically equal to that of the gas and coal stove as generally run, when electricity is supplied at 4 cents per h. p. h.

This does not show what can be accomplished under best control, but is a practical result in common usage.

The economy of electricity as a thermal agent in cooking is not doubtful, provided the uses to which the various forms of heat supply are put are proportioned in accordance with their heat-equivalents, limiting electricity to high-temperature work. In combination with steam, both live and exhaust, there appears to be no reason why hotels and public institutions, operating their own plants so as to secure a multi-potential system, should not employ electricity in cooking very extensively, solely for the purpose of economy; for electricity in a well-designed isolated plant costs much less than 4 cents per h. p. h., especially if we utilize the by-products of its generation in useful work, as would be the case in a complete thermal system. Ethical considerations in connection with electric cooking are of value after the economy and simplicity of the apparatus are established. Cleanliness, localization of heat at predetermined temperatures, and coolness of the kitchen are important factors in connection with the servant problem. The use of electric cooking apparatus in cooking-schools is important, as constant temperatures are easily produced over extended periods.

In industrial work the applications of electric heating are rapidly multiplying. Nearly every manufactory of size has its own electric plant, and can secure electricity at low cost. In operating sad-irons and tailors' gooses, small glue-pots, soldering-irons, pitch-heaters, &c., sufficient compensating advantages are found to offset increased prime costs, in case they occur, and the outlook for extended applications in the industrial field is favorable. The ability to minutely sub-divide the heat energy, or, in other words, the elasticity of the system, makes it of special importance for use in manufacturing work.

It is impossible, within the prescribed limits of this article, to give more than a passing glance at the different factors in electric heating. We may perhaps best sum up the various sides of the problem as follows:

1. In constructing a thermal system, we may employ electricity as the high-potential heat factor, by resistance heaters, or we may employ it as agent in operating motors to drive a suitable machine to secure diffused heat control.

2. In a multi-potential thermal system the useful heat available is practically five parts low-potential heat and one part high-potential heat. In domestic life the ratio of heat required is found to be practically five parts diffused heat and one part high-temperature heat. Over limited distances we may therefore economically operate multi-potential thermal systems using electricity as the high-potential factor.

3. Electric heating is synonymous with central-station heating,

presupposes the same generic elements, and requires for economy a complete thermal system, in which due regard is paid to proportioning the work done in accordance with the heat-equivalents of the factors employed, all of which must be in such form as to constitute elements of a telethermal system.

4. Where the mechanical equivalent of heat only is available, as from motors, water powers, gas engines, &c., we can economically employ electricity only for high-temperature work ; for diffused heating on a large scale we must employ it as agent.

5. By constructing complete thermal systems, in which steam and electrical engineering are factors, the heat engineer can make electric heating a source of wealth to the owner of the system and a source of economy to the user of the heat energy, and therefore secure an advance on existing heating systems.

MINING REPORTS AND MINE SALTING.*

By Walter McDermott.

THERE is such a great variety of badness in mining reports that a little grouping of the cardinal sins will be useful. In speaking of mining reports generally, for the purpose of illustration, I intend to cover, not only those made by mining engineers, but all those used in business, and so fairly subject to criticism,—from that of the learned professor of other sciences who is dragged from the seclusion of his study and put underground to be made miserable with candle-grease, down to that of the practical miner, who, having beaten a drill for a certain number of years, is prepared to dogmatize also on facts, figures, theories, and conclusions.

Amongst the old friends we meet in numberless reports, and which seem to need a little protection against excessive wear and tear, the following will be considered: (1) the true fissure vein; (2) increasing width in depth; (3) increasing richness as depth is attained; (4) junction of veins; (5) ore in sight; (6) proximity to a rich mine; (7) failure from mismanagement. Now, Heaven forbid that I should be held as speaking disrespectfully of any one of these things, each estimable in itself. My remarks are pointed only against their indiscriminate use, and particularly against their public use as catchpenny phrases in a way to imply more than they actually mean.

There has been more joy over the term "true fissure vein" than over anything else in the history of mining. The investing public has become intoxicated with the exuberance of its descriptiveness. The practical miner has grasped its effectiveness, and the first ring of his pick on an outcrop satisfies him he has got the genuine article with tap roots in the antipodes. What is a true fissure vein? It is supposed to be a fissure in the country rock filled with veinstone, which may be expected to go down to a considerable depth. The veinstone itself sometimes carries pay ore. This does not seem much to base any elaborate calculations on; and not only is it insufficient, but experience all over the world has shown that some of the most valuable ore deposits are not found in fissure veins at all. Even as far as mere depth is concerned, it is by no means yet established that true fissure veins go any deeper into the earth's crust than bedded deposits, contact, or pipe veins; and it would be of no consequence if they did go deeper, since they cannot be followed. Properly used, the term "true fissure" is usefully descriptive, but, where used as an incantation to call up visions of wealth to unlimited depth, it needs suppressing.

---

* Abstract of a paper read before the British Institute of Mining Engineers.

It is naturally gratifying to the owner of a mine to see his vein increasing in width as he goes down. It also looks well as described in a report, and must naturally be mentioned when it occurs; but in some reports the implication arises that it is a vital point and to be calculated on as continuing. If a vein went on increasing in width, it would very soon attain enormous dimensions; and, if it outcropped in a country blessed with the law of the apex, its lucky owner would have a good claim to a very large proportion of the earth when he got down a few miles. It may pretty safely be assumed that the increase in width will not continue, and, when it stops, it is very likely to be succeeded by a corresponding decrease, so as to keep up the usual average of things. When, say, a 50-ft. shaft sunk on a vein shows an increase in thickness from 1 ft. at surface to 6 ft. at the bottom, there is nothing to show that, in continuing to sink, the vein may not gradually or rapidly pinch again to its size at surface, or even much less. If any calculations were justifiable at all in such a case, general experience would certainly lead one to expect such decrease. The only positive conclusion would be that the vein is irregular in width. It looks nicer and more definite to say simply, "the vein is steadily increasing in width as sunk on," than to state that "the width of vein is variable, running from 1 ft. to 6 ft., and therefore, until further opened in length and depth, its average cannot be safely calculated on." The one statement is as true as the other, but the effect of the two in reading is not the same.

There is a touching confidence in the belief of many practical miners that veins get richer as they go down. Experience and disappointment often fail to shake this comfortable belief. Most practical men are able to cite a great many more examples of rich mines becoming poorer with depth than the reverse. I remember being struck with the inconsistency and persistency of the belief in depth in various camps of the Rocky mountains. Up in the highest ranges, say 12,000 ft. above sea level, there are mines which need sinking on to prove their real value; and 7000 ft. below them in the foot hills are mines equally needing depth. Probably the thought at the bottom of this belief rests, like some of the attractiveness of the true fissure veins, in the old idea of a central seething mass of precious metals, and in the forcing up of a molten vein-filling. This faith in the saving grace of depth and of true fissure veins in the face of facts can be explained only by the definition of faith as given by the little girl—"believing what you know is not true." The hankering for depth has its justification, of course, in the necessity for sinking usually to get any developments, but, where access is obtainable to the foot of a mountain through which a vein runs, the same men who claim a special efficacy for depth in other cases will point to the vast advantages of having the ground above one to be opened by adits. The facts of experience show that, when a vein is rich at the surface, a hope that it may continue is a more proper attitude than a belief that it will get richer in depth; and, when it is poor on surface, any change in sinking would be for the better.

Striking cases of enrichment of veins at their junctions occur; but, as many examples of junction without richness also exist, it does not do to attach too much importance to the results to be expected. In some reports the future junction of two veins is often itself assumed on insufficient data, and the consequences are calculated on with a certainty which is still less to be justified.

Under the head of "ore in sight" is included matter which is of the very greatest importance, and which requires the very best work of an engineer. The estimation of ore in sight in an opened mine often involves the consideration of so many points, and is so largely a matter of good judgment, that one may expect some discrepancy in the reports of different engineers. There is nothing in which such vast discrepancies do exist, in fact, as in regard to this. Two good engineers will vary in their estimate; and, when it comes to inexperienced men, or to so-called practical men who have no reverence for the written word, the term "ore in sight" becomes a theme for the exercise of the highest flights of imagination and the airing of a little rudimentary mathematics. In the common mining report we are all acquainted with, it is not unusual to see the length of the chain multiplied by a cheerfully assumed average width of vein, then by 500 or 1000 ft. for depth, and a tonnage deduced which reminds one of the figures used for astronomical purposes. Sometimes, to inspire extra confidence, the expert generously knocks off 25 or 50 per cent., and feels he has then done his duty, whatever happens. The character and ability of a man can sometimes be closely estimated from the way he figures up ore in sight after giving the dimensions bearing on it; and it often suffices to look at this calculation in order to determine a report to be, not only quite unreliable as to conclusions, but equally irresponsible as to data.

In connection with estimation of ore in sight, the system of sampling employed is worth mentioning here. In some reports the expert writes of taking samples "at random." When a man says he has picked some samples from a dump "at random," and they assay well, he implies that such ore is plentiful on the dump, and that he did not purposely select it from its appearance. What his statement actually means is that on an important matter he was willing to trust to luck as to whether he hit poor or rich ore, or whether he was getting just what had been previously placed for him to get. Luck is a very necessary thing in mining, but it should not enter into sampling. If the sample is a random one, its value proves nothing. Some people seem to think this method of sampling is important evidence of an impartial mind, and that shutting the eyes is the best security against the frailty of human nature, which would otherwise lead a poor creature to pick out the richest looking ore he can find.

Another little weakness to be remarked in some reports is the willingness to make a liberal discount off the expert's own figures. The writer concludes, for instance, from his samples—perhaps taken at random—that a gold vein will average 2 ounces of gold to the ton, but, to be on the safe side, generously offers to take it at 1 ounce, and then with a light heart goes into calculations of profits by day, and month, and year. If a man knocks off 50 per cent. from his supposed reliable figures to be safe, it always occurs to me that the one who reads his report may feel tempted to lop off another equal percentage to be still safer.

There have been plenty of illustrations lately published in prospectuses of the great value the public places on a property which is near a well-known mine ; yet everyone who knows anything of mining must be aware that mere proximity to a paying mine gives no assurance of similar success. Some of these reports are absolutely nothing but a statement that the claim examined is on the same reef as, or near to, another property which is popularly supposed to be exceedingly valuable, and that rich ore has been found on the claim.

In quartz mining it sometimes happens that a series of paying mines are found at intervals along a single vein. Occasionally the intervals between pay shoots are long, so that a good mine may be immediately surrounded by poor ores. In other districts one single good mine on a vein is all that is ever developed. The only actual advantage of the proximity of a good mine is the evidence it affords of there being payable ore in the district, or on a certain reef. Like other indications, it is of service only when used with discretion, but as an unqualified argument of the value of a neighboring claim it is most dangerous.

That bad management may spoil a good mine is so self-evident a proposition that no one will misunderstand a few remarks against the improper or thoughtless use of this excuse in a report as an explanation of previous failure in a poor mine. A well-known Californian mining man, when asked to take charge of a mine which had failed to pay—as it was explained—from mismanagement, answered that he did not want anything to do with a mine which would not stand bad management. This is a remark which contains much matter for reflection, and embodies the opinion of most practical men. In reports the statement is sometimes loosely made that milling results in the past cannot be relied on, owing to primitive machinery or processes hitherto employed. This argument has often been advanced on Mexican mines by experts who have not had time to find out that native methods of working often give better results than the rapid working by the most modern machinery.

After all these remarks as to what mining reports ought not to be, it is perhaps permissible to say a few words on what they ought to be. A report need not be long-winded to justify the fee paid for it, but should be so full in actual description as to enable a reader experienced in mining to draw his own conclusion from the facts given, without having to trust entirely to the deductions of the writer. Where a fee is paid for a simple expression of opinion or specific advice, there is no need of a report, in the sense of the word as we are now considering it. The important details to be set forth clearly are those relating to position, and facility of access to the property ; local conditions as to fuel, water, and timber supply ; extent and form of openings : variations in thickness of deposit ; character and value, and form of occurrence, of ore. It is important in giving a clear idea of the property that the distribution of the payable ore in the deposit should be described. It makes a great difference sometimes in the conclusions to be drawn whether the value consists in rich ore occurring in a barren vein mass, or in high-grade ore scattered through a low-grade deposit, or in a uniform value throughout the rock. On account of the necessity for this description it is not always sufficient to state that an average width of vein contains an average of so much value per ton, as this may be in the nature of a conclusion, not of a fact, and so may need to be justified by detailed facts of the report. The extent and character of dump piles at a worked mine often afford valuable confirmatory evidence as to the character and value of the property.

Geology and mineralogy should naturally be used with discretion, but only for purposes actually bearing on the description and conclusions to be drawn,—not for mere padding nor for the airing of theories better treated in a purely scientific paper. I have seen a report which started with the nebular hypothesis and traced the progress of the earth from its pulpy state right down through its various stages to oxidation of the outcrop of a particular vein in the year of grace in which the report was written. These details were so full that there was no room left for anything but a very brief treatment of the merely commercial question of the value of the mine.

Examinations naturally differ greatly in the nature of the calls they make on the expert. In a district with which he is well acquainted there are often certain simple facts which enable him rapidly and safely to arrive at his conclusions ; in other cases it is often a matter of hard and conscientious work, however clever or experienced the engineer may be, and any scamping of this work will imply unreliableness. An experienced man in making a report will have an open mind for possible new forms of ore occurrence, while refraining from prophecy about things not in sight. Events may work against the most careful and experienced man by unforeseen increases or decreases in value on opening new ground ; but, as mine examination is an art and not an exact science, it is by average results that an engineer must be judged.

There are all degrees of "fixing a mine" : from the legitimate showing of its best features by not taking out all the rich ore before offering for sale, or by various degrees of skulduggery, up to palpable salting of mines, dumps, and expert's samples. In the less illegitimate stages much can be done, and very frequently is done, in the way of a judicious stoping of faces in good ore, and by the observing of a discreet silence as to past weaknesses and irregularities of the ore deposits. In such cases it is simply the ordinary commercial position of "let the buyer beware," and the expert has to show by his report if he has experience, observation, and sense enough to form a sound judgment as to value.

In a mine which is thus carefully prepared for selling, it is not at all uncommon for the owner to go beyond the legitimate limit already indicated, and to misrepresent facts by filling up or concealing old workings which would, if examined, produce an unfavorable impression. The next step in the downward path which leads to a hotter place (but in the meantime also sometimes to affluence) is the scooping-out of the inside of apparently solid blocks of good ground by openings afterwards filled up or timbered over. Some of the most experienced mining men and engineers have fallen victims to this and the previously described course of conduct ; while some have just escaped being caught by a mere accidental indication of the fraud, or by "peaching" of some miner who helped in the work and had not been squared. Naturally the danger from the sources mentioned is much less in new mines of limited extent than in old mines extensively developed. In a mine which has been worked for some time the visiting engineer is at a great disadvantage as compared with the men who have worked in it for years, and perhaps devoted their greatest skill to making, not only a good record, but to concealing the exhaustion which is approaching. It happens occasionally also that the owners complete their work by "picking the eyes out of the mine" in the interval between the expert's report and the turning over of the property to the purchasers. The richer the nature of the pay ore in the mine, the greater the danger from this rascality, which needs specially providing against in the terms of purchase, and by other precautions.

The above-mentioned very real and not uncommon dangers, against which the engineer has to guard, are not, however, "salting" in its proper and technical sense, which is generally understood as covering any interference with the expert's chance of arriving at a true estimate of the value of ore. The salting may be done on the ore before the expert's arrival, or during his sampling, or on his samples when taken, or while panning or assaying.

Although cases are well known of faces in a mine being salted with such success as to catch the unwary, this form of salting is usually too difficult to carry out, and too superficial in character to offer much chance of catching an old bird. With ore dumps and alluvial deposits it can be done with better chances of success, but is naturally of an expensive nature if carried out on a really systematic plan. Cases are on record of successful salting of alluvial ground with precious stones as well as with gold, and the expert must clearly be on the watch against this, when circumstances allow of the possibility of its occurrence With ore dumps it is often very easy to arrange a veneering of good ore over a very large pile of poor or barren rock, and then, when the ingenious gentleman who takes samples "at random" comes along, he will be sure to obtain a gratifying result.

The salting of samples is, however, much more common than any other form of getting ahead of the expert. It is less expensive than salting in advance, more deadly, and can be nicely adjusted to circumstances and to the individual weakness of the victim. When the owner of the mine, or anyone connected with him, is allowed to assist in the sampling itself, there is no lack of opportunity with some ores for the artistic salting while in the mine; but, as a rule, engineers do not have the requisite faith in human nature to accept such assistance, unless the character of the ore and kind of samples required make salting impossible at the time. In a strange district, where assistance of some sort has to be obtained in breaking and transporting large samples, and the character of such assistance is not absolutely certain, the engineer must guard himself by duplicating entirely alone certain test samples. Assuming that samples have been secured without any chance of outside interference, the business is by no means ended, for the enterprising salter will follow those samples until actually panned or assayed, or taken out of his reach.

To the successful cultivation of the art of salting no great knowledge or experience of mining is necessary, any more than a study of architecture is essential to the practice of burglary. True ability will assert itself in this as in other employments by the invention of new means to meet special cases, and by a proper discretion in regulating the dose of salt administered to the temperament of the patient.

Sometimes the honest miner will freely relate stories of methods by which experts had been salted, implying delicately that no such schemes would be successful with his hearer, but reserving one, undescribed, for purposes of personal illustration later.

The microscope or a very strong glass is often of great service. In silver ores the silver-bearing minerals can often be washed out and identified; and with gold ores the color and form of the metallic particles are sometimes suggestive. Once, in Dakota, I was taken to see a vein said to be rich in silver, but the appearance of the vein-matter raised an immediate doubt as to what form the silver could be concealed in. By panning I obtained some native silver; but when examined under a glass some of the pieces showed traces of native copper attached. The only place I know where native silver and copper occur actually welded together is the copper region of Lake Superior; and, on questioning a little the honest miner who was my guide,—and who had kindly assisted in crushing some samples,—I found he had formerly worked on Lake Superior. No great intellectual effort was then necessary to account for the occurrence of the silver in the very unpromising looking vein-matter.

In the case of panning tests on gold ore, or gravel, or for precious stones, it is of course comparatively easy for anyone who is allowed to be within a short distance of the expert to get in his salting work, and solitude is the only protection. The salter may use a quill toothpick as a weapon for long-range shooting, or have gold dust in his nails for short range; or charge his pipe or cigar, and not watch where his ashes fall. Cases have been known of gold pans prepared in advance by a valuable varnish which gradually rubbed off in use. Although it is not possible to mention all the devices, there may be some utility in putting on record for others the better-known ones; for it is certain that many young engineers start out with confidence of much learning, ready to undertake responsible examinations, and without any clear idea of the dangers they are courting. A man may acquire a fair amount of practical experience, and confidence begotten of the same, without happening to get into surroundings of any real danger, and so, when least expecting it, may yet be nipped. All men of experience agree that the only absolute protection is solitude; and that trusting to knowledge of the old tricks or to personal watchfulness is quite insufficient if any person is immediately around.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

INTRODUCTORY.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

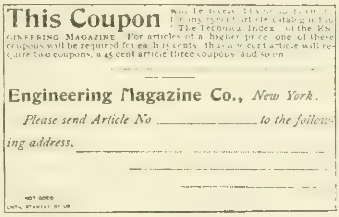
We hold ourselves ready to supply—usually by return mail—the full text of every article reviewed or indexed, and our charge in each case is regulated closely by the cost of a single copy of the journal from which the article is taken.

☞ The price of a single article is ordinarily 15c.; those indicated by an asterisk (*) 30c.; by a dagger (†) 45c.; and above this, the price is given just after the number. In ordering from us care should be taken to *give the number* of the article desired, not the title alone.

The entire Review is conveniently classified into the recognized divisions of applied science—everything pertaining to "Architecture and Building" appearing under that heading, while "Civil Engineering" is given under that title, and so on alphabetically throughout. The titles, addresses, and initials of all the journals regularly reviewed are given alphabetically below, but in the body of the Index only the initials are given. Other abbreviations used are, Ill=Illustrated; W=Words.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell coupons—represented here in miniature.

The price of these coupons is 15c. each, or fifteen for $2, forty for $5, and one hundred for $12.



This Coupon will be received by us in payment for any 15 cent article catalogued in The Technical Index of the ENGINEERING MAGAZINE. For articles of a higher price one of these coupons will be required for each 15 cents; thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on.

Engineering Magazine Co., *New York.*

Please send Article No ________ *to the following address.* ________

NOT GOOD UNTIL STAMPED BY US

Simply fill in the number, and your address. A stamped envelope does the rest. No letter-writing is required.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their great convenience and economy.

THE PUBLICATIONS REGULARLY REVIEWED.

A	Arena. *m.* $5. Boston.
AA	American Architect. *w.* $6. Boston.
An A A	Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An	American Analyst. *f.* $1. New York.
A & B	Architecture and Building. *w.* $6. N. Y.
A B D	Arch. Build. and Dec. *m.* $2. Minneapolis.
A C J	Am. Chem. Journal. *b-m.* $4. Baltimore.
A E C U	Asso of Eng. of Cornell Univ. 1894. Ithaca.
A E R J	Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G	Am. Geologist. *m.* $3.50. Minneapolis.
A G L J	Am. Gas Light Journal. *w.* $3. New York.
A J S	Am. Jour. of Science. *m.* $6. New Haven.
A L	The Architect. *w.* 26*s.* London.
A M	American Machinist. *w.* $3. New York.
A M C	Amer. Mag. of Civics. *m.* $3. New York.
Am M	American Miller. *m.* $2. Chicago.
Am S	American Shipbuilder. *w.* $2. N. Y.
A M & I W	Am. Man. and Iron World. $4. Pittsburg.
A M S	Aust. Mining Standard. *w.* 30*s.* Sydney.
A R	Architectural Record. *q.* $1. New York.
Arch	The Archæologist. *m.* $1. Columbus, O.
A Rev	Architectural Review. *s-q.* $5. Boston.
A S	Age of Steel. *w.* $3. St. Louis.
A S I E	Amer. Soc. of Irri. Eng. *qr.* $4. Denver.
A S M E	Am. Soc. of Mec. Eng. *m.* New York.
B	The Builder. *w.* 26*s.* London.
B A	The British Architect. *w.* 23*s.* 8*d.* London.
B B	Brick Builder. *m.* $2.50. Boston.
B G S	Bul. Am. Geog. Soc. *q.* $5. N. Y.
B I S	Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C	Boston Jour. of Commerce. *w.* $3. Boston.
B M	Banker's Mag. *m.* 18*s.* London,
B M A	Bankers Mag. of Australia. *m.* $3. Melbourne.
B T J	Board of Trade Journal. *m.* 6*s.* London.
B U W	Bul. of the Univ. of Wisconsin.
C A	Calif. Architect. *m.* $3. San Francisco.
Can A	Canadian Architect. *m.* $2. Toronto.
C E	Colliery Engineer. *m.* $2. Scranton, Pa.
C Eng	Canadian Engineer. *m.* $1. Montreal.
C G	Colliery Guardian. *w.* 27*s.* 6*d.* London.
Ch	Chautauquan. *m.* $2. Meadville, Pa.
C M	Century Magazine. *m.* $4. New York.
C M R	Canadian Mining Rev. *m.* $1.50. Ottawa.
Com	Commerce. *w.* 36*s.* London.
Cos	Cosmopolitan. *m.* $1.50. New York.
C R	Contemporary Review. *m.* $4.50. London.
C T J	Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
D E	Domestic Engineering. *m.* $2. Chicago.
E	Engineering. *w.* 36*s.* London.
E A	Electrical Age. *w.* $3. New York.

E & C....Engineer & Contractor *w.* $1. San Francisco.
E A S....Eng. Asso of the South. *m.* $3. Nashville.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E L....Electrical Engineer. *w.* 19*s.* 6*d.* London.
E E N Y..Electrical Engineer. *w.* $3. New York.
E G......Engineers' Gazette. *m.* 8*s.* London.
E I.......Electrical Industries. *m.* $1. Chicago.
E L.......Electricity. *w.* 7*s.* 6*d.* London.
El .....Electrician. *w.* 24*s.* London.
E M......Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York
E M J....Eng. and Mining Journal. *w.* $5. N.Y
E N......Engineering News *w.* $5. New York.
Eng .....Engineer. *s-m.* $2.50. New York.
EngL... Engineer. *w.* 36*s.* London.
E N Y....Electricity. *w.* $2.50. New York.
E P......Electrical Plant. *m.* 6*s.* London.
E R......Engineering Record. *w.* $5. New York.
E Rev....Engineering Review. *m.* 7*s.* London.
E R L.....Electrical Review. *w.* 21*s.* 8*d.* London.
E R N Y..Electrical Review. *w.* $3. New York
E S W P...Proc. Eng. So. of W.Pa. *m.* $7. Pittsburg.
E W......Electrical World. *w.* $3. New York.
F .....Forum. *m.* $3. New York.
F D......The Foundry. *m.* $1. Detroit.
F R......Fortnightly Review. *m.* $4.50. London.
F W......Fire and Water. *w.* $3. New York.
F'y......Fairplay. *w.* 32*s.* 6*d.* London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G & F....Garden and Forest. *w.* $4 New York.
G M.....The Geol. Mag. *m.* 18s. London.
G W. ....Gas World. *w.* 13*s.* London.
H & V...Heating and Ventilation. *m.* $1. N. Y.
I A......Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
I E.......Indian Engineering. *w.* 18 Rs. Calcutta.
I Eng....Indian Engineer. *w.* 20 Rs. Calcutta.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25*s.* Lond
I C B... .Carpenter and Builder. *w.* 8*s.* 8*d.* London.
ICT .....Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
Inv.. ..Invention. *w.* 11*s.* London.
Ir Age..Iron Age. *w.* $4.50. New York.
I R W. .India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J G L....Journal of Gas Lighting. *w.* London.
J N E W.Jour.N.E Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J S A... Journal of the So. of Arts. *w.* London.
L E..... Locomotive Engineering. *m.* $2. N. Y.
L. H. P..Light, Heat and Power. *m.* $3. Phila.
M........Machinery. *m.* 9*s.* London.
M A.. ..Machinery. *m.* 50 cts. N. Y.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M E......Marine Engineer. *m.* 7*s.* 6*d.* London.
Met W...Metal Worker. *w.* $2. N. Y.
Mill......Milling. *m.* $2. Chicago.

Min. R...The Mining Review. *w.* $2. Denver.
M I T ...Mining Industry. *w.* $3. Denver.
Min W..The Mining World. *w.* 21*s.* London.
M J. .. .The Mining Jour. *w.* £1. 8*s.* London.
Mo ...The Monist. *qr.* $2. Chicago.
M R .Manufacturer's Record. *w.* $4. Baltimore.
M S F....Master Steam Fitter. *m.* $1. Chicago.
M S P... Min. and Sci. Press. *w.* $3. San Francisco.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N... ...Nature. *w.* $7. London.
N A R...North American Review. *m.* $5. N. Y.
N B .. ..National Builder. *m.* $3. Chicago.
N C.. ...Nineteenth Century. *m.* $4.50 London.
N C B...National Car Builder. *m.* $2. New York.
N S R....The New Science Review. *qr.* $2. N. Y.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
P ....Paving. & Mun. Eng.*m.* $2. Indianapolis.
P A .....Progressive Age. *s-m.* $3. New York.
P E C P.Procd. Engineer's Club. *q.* $2. Phila.
P Eng...Practical Engineer. *w.* 10*s.* London.
Pl D .....Plumber and Decor. *m.* 6*s.* 6*d.* London.
Pr.......Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1 New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .Railroad Gazette. *w.* $4.20. N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R P L....The Railway Press. *m.* 7*s.* London.
R R......Railway Review. *w.* $4. Chicago
R W.....Railway World. *m.* 5*s.* London
Ry T.. ..The Railway Times. £1. 5*s.* London.
S... .....Stone. *m.* $2. Chicago
S A......Southern Architect. *m.* $2. Atlanta.
San......Sanitarian. *m.* $4. Brooklyn
Sc.... ...Science *w.* $5. Lancaster, Pa.
Sc A.....Scientific American. *w.* $3. New York.
Sc A S ...Scientific Am. Supplement. *w* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Col.
S E......Stationary Engineer. *m.* $1. Chicago.
S Ec ....Social Economist. *m.* $1.50. N. Y.
Sea......Seaboard. *w.* $2. New York.
S In......Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L......Steamship. *m* Leith, Scotland.
S M.....ScientificMachinist.*s-m.*$1.50. Cleveland,O.
S M Q....School of Mines Quarterly. $2. N. Y.
S R......Sanitary Record. *m.* 10*s.* London.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P......Sanitary Plumber. *s-m.* $2. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V......Safety Valve. *m.* $1. New York.
T... ....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E... Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q......Technology Quarterly. $3. Boston.
Tr.......Transport. *w.* £1. 5*s.* London.
Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A...Trans. of the Wis. Acad. Madison.
W E......Western Electrician. *w.* $3. Chicago.
W R.....Westminster Review. *m.* $4.50. London

ARCHITECTURE & BUILDING

Insanitary Dwellings.

A MORE than ordinarily forcible and instructive lecture on uninhabitable and insanitary dwellings was recently delivered before the Unionist Club at Leith by Mr. William Stevenson, a house factor, as real-estate agents are styled in Scotland. Few real-estate agents in the United States could make such a deliverance. The lecturer aimed to point out some of the primary causes of insanitary dwellings, and to suggest what he thinks would be a successful remedy. The speaker first considered what has been asserted for the last 50 years to be the most potent cause,—reiterated as such at the Sanitary Congress in Glasgow last August by Dr. Russell, who laid the blame for insanitary dwellings on "the immoral compact entered into between the tenant and landlord," and, more rhetorically than logically, said that "this compact was leading landlords, factors, trustees, beneficiaries, bondholders, and tenants down the broad road to perdition." A political orator, Mr. Chamberlain, implied in a recent speech that houses became unhealthy because every man was not his own landlord, and named as the condition of healthy houses that they should be owned by their occupants. Mr. Stevenson, whose lecture is reported in *The Architect* (London, March 1), adduced strong evidence to prove that the opinions put forward by Dr. Russell and Mr. Chamberlain (but by no means confined to them) are fallacious. Edinburgh and Leith are cited as two cities preëminently characterized by ownership of homes by their occupants, and this ownership has extended back for generations. Of such of these houses (owned by their occupants) as have been built during the last 15 years, the lecturer queried whether one fourth would be found in a state to fully meet the requirements of tenants and stand modern scientific tests for sanitary conditions. How has it come about "that the houses that have been built even at a very recent date, and which, when built, were constructed on the most approved plan and fitted with sanitary appliances and other modern conveniences of the then most perfect kind, should in a very few years become, so to speak, unhealthy?" This outcome of such ownership is explained as follows:

"I think it will be found that comparatively little is held in ownership by the upper or wealthy classes, but that it is held by the lower or less wealthy classes, not for speculation, but as a sure and safe investment, and held by persons who have acquired the means they are possessed of by care and frugality, and who have invested the whole, or nearly so, of their means in property as a competency for old age for themselves and wives, and with the expected reversion to their families or relatives after their death. In the investing of their carefully-gathered means little account has been taken of, and no provision has been made for, the continual outlay required for the repairs and up-keep which is necessary on house property. If money has been borrowed on bond and mortgage, as is often the case, the strain on the resources of the holding to make all ends meet is excessive. Every penny possible requires to be exacted from the rents by the life-renter. Not more than what is absolutely compulsory is expended either on repairs or improvements. The better class of tenants gradually remove to houses of more recent construction, and where they find the more modern appliances and conveniences. The houses have to be let to a class of more undesirable tenants, and gradually the property gets into disrepair, and from bad to worse goes down the hill, till ultimately, when it reaches the beneficiary, it is scarcely worth having." It is in this liability of houses to get out of repair, and the lack of adequate provision to keep them in repair, that the chief causes for existing insanitary conditions are found; and the lecturer, tracing the various phases under which property is held by occupants, including life-rental, finds this cause at work among all the classes of individual owners of the property, except the wealthier classes. The remedy prescribed does not seem as practicable and adequate as the clear diagnosis of the disease might lead the reader to expect.

"I would like to see, and I recommend that the owning of house property be taken up by joint-stock companies, or such like corporations, or of some kind of syndicate, which might be limited, and might be coöperative. In the formation of such companies and corporations there could be no risk, if judiciously gone about. The property would be managed from year to year on uniform and business principles and with perpetual succession in the management,—uniform, continuous not erratic, spasmodic, and uncertain. The dividends would be paid half-year and half-year, uniform, and of known quantity, with sufficient reserve for all emergencies or improvements and for renewals. I see no reason why workingmen of all classes should not join in and invest their frugal savings in such a manner from the single one pound and upwards. Such investments would not be speculative,—expected to yield from 6 to 10 per cent.,—but I see no reason why a uniform and constant dividend of 4 to 4½ per cent. should not be made. In such companies, owning whole and undivided blocks of houses, and having no mutual obligations, improvements in internal arrangements and fittings, and the introduction from time to time of the modern and approved sanitary appliances, could be done with perfect facility and freedom, as it was found that they became necessary and advantageous for maintaining the houses in the best and most forward condition; and, by always keeping the houses in such forward condition and retaining and keeping the best class of tenants, maintaining the locality also in a high-class position. In such companies or corporations shareholders and members could with every confidence bequeath the life-rent to one person, and the fee in the reversion to others, knowing that the life-renter would have no control in deteriorating the principal, and that the fee would go down to the reversionaries unimpaired, and in the same substantial condition in which it was left at the date of bequest."

The American School at Rome.

THE New York *Evening Post* having printed a sketch of the origin and aims of the new School of Architecture at Rome, *Architecture and Building* (March 9) republishes the article, which relates to an important effort to improve American architecture and to afford increased facilities for improvement to advanced students after they have taken the courses now published in American schools of architecture. The object sought is the furtherance of "the work of the institutions in America now offering courses in architecture," thus promoting regular progressive academical training. The school "offers a post-graduate course, open only to the beneficiaries of the traveling scholarships connected with those institutions, to those who have acquitted themselves with signal ability in the examinations for those scholarships, and to members of the *École des Beaux-Arts* in Paris, of at least three years' standing. Other well-accredited students are admitted to certain hospitalities of the school at the discretion of the secretary. Cornell University, the Institute of Technology in Boston, Columbia College, and the University of Pennsylvania have well-established schools of architecture. Harvard University has taken significant steps toward the establishment of courses in architecture, and Yale University has them in contemplation. There are at present traveling scholarships at Columbia College, Cornell University, and the University of Pennsylvania, and, in addition, the Rotch scholarship in Boston, which is not connected with any institution."

An assurance that the work of organization is in excellent hands is afforded by the names of the managing committee, all in high esteem as practising architects or as instructors in the art. "The managing committee consists of R. M. Hunt, C. F. McKim, W. A. Boring, W. M. Kendall, Augustus St. Gaudens, J. Edward Simmons,

H. G. Marquand, Samuel G. Ward, and J. A. Garland of New York; R. S. Peabody and Martin Brimmer of Boston; D. H. Burnham and Franklin McVeagh of Chicago; George E. Leighton of St. Louis; and the chiefs of the departments of fine arts or of architecture in the principal institutions which maintain courses in architecture,—namely, Prof. Norton of Harvard College, Prof. Babcock of Cornell University, Prof. Chandler of the Massachusetts Institute of Technology, Prof. Ricker of the University of Illinois, Prof. Ware of Columbia College, and Prof. Laird of the University of Pennsylvania."

At a meeting held at the Century Club, New York, June 12, 1894, an executive committee was appointed and instructed to select a managing committee. Notwithstanding that a year has not passed since this action was taken, it is stated that "the institution has already developed into an undertaking of much greater magnitude than at first was contemplated." The consensus of opinion with those interested in the enterprise is in favor of directing the work of beneficiaries to a common purpose, instead of, as heretofore, permitting them to travel from place to place, "filling their sketch-books with miscellaneous material and sending home but few carefully-measured drawings," this kind of work evincing "individually little intelligent prosecution along consistent lines." It was therefore finally decided to found an institution upon a broader basis than the atelier at first proposed, and "one which in the course of time should equal in endowment and advantages the foreign academies at Rome, although somewhat different in its scope and object."

Prolonged stay is to be encouraged for the purpose of more thorough study and the acquisition of an "application of true spirit of classic art."

"The school was formally opened under the charge of Austin W. Lord as secretary, and began its work on the 1st of November last in eight rooms, occupying the upper story of the *Palazzo Torlonia*, on the southwest corner of the *Via Condotti* and the *Via Bocca di Leone*, between the *Corso* and the *Piazza di Spagna*. In the absence of settled organization, it will require another term before the school may be said to be fairly launched, but it is satisfactory to note that the four traveling scholars this year abroad there have been following the course of the school." Departments in painting and sculpture are to be established. An extension of the scope to include archæology and epigraphy is to be considered at the May meeting of the Archæological Institute in Philadelphia.

Designing a Hotel.

BELOW is a condensation of an abstract printed in *The British Architect* (March 1), made from a report by Mr. W. Hamilton Beattie, accompanying a design also prepared by him for the New Edinburgh Railway Hotel and offices for the North British Railway Company. The design submitted by Mr. Hamilton was accepted, and the building will be erected accordingly. The purposes to which the design has been made subservient are apparent in what follows:

The plan must be simple, with straight, well-lighted corridors and easy and readily-found staircases and elevators. The guest, on arrival, must be able at once to reach the office to procure his room, and to proceed there directly, withoul delay or *détour*, which are most aggravating to a tired traveler. In a hotel where travelers arrive and depart on two different sides of the building and on entirely different levels this necessitates two offices. The hotel office should command the principal entrances, so that every one entering or leaving the hotel may be under supervision.

The public rooms should have the best views, and should be in such positions as will be most convenient for the special class of guests chiefly using them, and as will cause the least interference with guests not using them. For example, the smoking-room and billiard-rooms should be in readily-accessible, but retired, situations, where they will not interfere with the comfort of the lady guests. The children's room should also be in such a position as will not annoy the more important guests.

The kitchen should be large, well-lighted and ventilated, and in a central position, from which rapid service of food may be made to every apartment in the hotel requiring it. Nothing aggravates guests more than slow service or cold food. All the administrative apartments should cluster round the kitchen in a compact and easily-accessible plan, so as to secure the smooth working of the establishment and an absolute check upon all stores arriving or being issued, and upon all cooked provisions or liquors being sent to the visitors.

The working arrangements should be planned so that the hotel may be run with the minimum staff of servants, and so that the last ounce of value may be got out of all fuel and other stores used. For example, the same steam-boilers should provide the motive power for heating, cooking, washing, ventilating, electric light, elevators, &c., and, as in a triple-expansion engine, the heat should be utilized to the last possible degree. Outsiders have no idea of the large sums which may be saved in the working of a hotel by the careful planning and economical combination of these arrangements.

The bed-rooms should be of fair size and varied in dimensions, so as to accommodate both married couples and single visitors. The shape of hotel bed-rooms is somewhat important, as they are more occupied than in private houses, and, in addition to the usual furniture, have also to accommodate trunks and travellers' luggage. The best shape has been shown by experience to be a long parallelogram. On the principal floors there should be suites of sitting-rooms, dressing-rooms, and bathrooms to meet the requirements and purses of wealthy travellers. Careful provision should be made for the rapid and efficient service of both the private sitting-rooms and the bed-rooms upon each floor, and for a prompt attendance on visitors' rooms both day and night. Nothing makes a hotel more unpopular than defective service and delays in answering bells. The measure of the earning-power of a hotel is the bed-room accommodation, and the more numerous its rooms are, the better it will pay; especially in the upper flats is the number of bed-rooms more important than their size.

Everything connected with a hotel should, as far as possible, be done on the premises. For example, by having an efficient washing-house and laundry, the profit from the washing of the visitors' linen will nearly cover the cost of doing up the hotel, bed, and table linen, and the hotel servants' washing. Moreover, the washing is done better and quicker than outside, and delays and losses with visitors' washing avoided. Another most profitable arrangement is for a hotel to bake its own bread. In these days of cheap corn the profit earned is large, and will keep the hotel servants in bread for nothing.

Every first-class railway hotel should do an extensive restaurant and bar business. This is very profitable, and can be easily managed in connection with the hotel. Every first-class hotel should do a wine and spirit merchant's business, and should have a special shop or office for conducting it. Considerable stocks of wine and spirits must be kept and matured by the hotel, and it greatly increases the turn-over when these are sold in larger quantities.

The arrangements for the housing of the hotel servants should be carefully considered. These have hitherto been much neglected, which is a serious mistake, as good servants will not remain unless they are made comfortable. Hotel servants are notorious for their constant changes and bad qualities, and this, to a considerable extent, arises from the way in which they are treated as regards feeding and sleeping, accommodation, baths, and sanitary arrangements. It pays well to make them comfortable in these respects. It is hardly necessary to add that the number of servants bears a fixed proportion to the number of guests, and that servants' accommodation must be provided accordingly. If this is not done, the servants must occupy bedrooms that could otherwise be let to guests.

How to Prepare Mortar.

ENGINEERING, N. Y. (March 16), contains a letter from Mr. Edward Wolff, which, in view of recent occurrences in

New York, is of interest as showing defective methods of mortar-making employed by builders, and as giving the proper method of slacking lime, preserving it in good condition after slacking, and preparing from it strong, adhesive mortar.

"The slacking operation should be done in a water tight box made of boards, and so much water should be mixed in that the contents will never get dry, and a sheet of water will remain on top to prevent access of air. If the box will not hold the entire quantity of lime required, the contents may be emptied into a cavity made in the ground close to the pan, and this process may be repeated. This should be done at least two weeks before sand is added, or before the mortar is prepared for use. Slacked lime prepared and kept as stated has been found free of carbonic acid after many years, air and gas having not been able to find access. Instead of following the procedure in slacking lime recommended above, we see in this country, or at least in the neighborhood of New York, a faulty process adopted, which consists in loosely mixing the sand with the slacking lime immediately after water has been added, and forming a dry heap on the surface of the ground, which is left lying there several weeks to give time for complete slacking before the sand is worked in evenly and the mortar considered ready for use. This heap arrangement is perfectly adapted to circulating air through a material which should be guarded against contact with air. The sun heats the surface of it, makes the air escape after it has given up its share of carbonic-acid gas, while at the base of the heap and at the shady side a fresh supply enters to fill up the vacuum after it has circulated through the heap and has been robbed of its share of carbonic-acid gas. That this procedure really happens in such a heap we can easily see when we place a lump of freshly-slacked lime in a wine-glass and in another glass place a small quantity of material taken from a heap such as described, and which has been prepared a few days before; fill both glasses nearly up with water, and add a few drops of muriatic or sulphuric acid to each. In the first glass nothing can be observed, while in the second glass we will see in the shape of small bubbles the carbonic acid escape, which has been absorbed by the lime from the atmospheric air circulating in the heap." It is reasoned that, as the hardening of mortar after mason-work results from slow absorption of carbonic acid from the air, if this be allowed to take place to any considerable extent before the mortar is used, a granular and non-adhesive condition of the mortar results, and a strong wall can not be made with it.

Padauk.

THE above is the name of a tree whose wood seems likely to come into favor for ornamental purposes, and which is even now being exported in considerable quantities from East Indian ports, chiefly to France and Belgium. *The Indian Engineer* (Jan. 5) gives a description of this tree and its timber, which certainly seems to be a remarkable material. It is much denser than teak, weighing from 56 to 80 lbs. per cubic ft. White ants do not attack it, probably on account of its density, but possibly because of a peculiar principle contained in its sap, which, when evaporated, yields a gum very similar to, if not chemically identical with, the gum Kino used in medicine. The tree sometimes grows to a great size. A plank of the timber 4 ft. wide was sent to the last Paris Exhibition, at which also its possibilities for furniture were displayed. However, the squared logs exported are usually about 16 ft. long and about 1 ft. 6 in. in thickness. The color of the wood varies from a color darker than mahogany to a flame-red, the latter being the favorite color. The roots are much more finely colored and marked than the trunks of the trees. The wood is said to season well and work well, and to be capable of taking a fine polish. It costs more to work than mahogany, but the extra cost is said to be repaid by the beauty of the finished product.

It is stated that the effects obtainable by the use of padauk wood for furniture and for interior architectural work are only rivaled by the richest and most perfect specimens of Spanish wood. Under the process of polishing, the figure in the wood, as well as the tone and color, becomes rich and beautiful. A very fine dado for a stone staircase in a London (Fenchurch street) church is cited as an example of the beautiful effects attainable, and a description of a drug store fitted up with doors and windows of padauk is quoted from *Timber*, which states that the effect is unique, and that both the color and figure of the wood are all that can be desired.

SPEAKING of principles that should guide repair of Ancient Buildings *The British Architect* says: "There has perhaps been no more abused term than that of "judicious restoration." Under cover of this elastic definition many an old historical structure has been divested of its main interest and charm. Possibly we are growing a little wiser and more discerning, and consequently the rage for "restoring" anything and everything — even with enamel paint—has in some sort abated. Modern imitation of old work is to be deprecated.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

†29154. Padauk. Editorial (I Eng–Jan. 5.) 1500 w.

*29956. The Proposal to License Architects. John Beverley Robinson (E Mag–May.) 3000 w.

29965. The Proposed Tenement House Law. Editorial (A & B–March 9.) 900 w.

29967. The American School of Architecture at Rome. From the N. Y. Evening Post (A & B–March 9.) 2000 w.

29968. The Licensing of Architects. A Plea Against Professional Disgrace. Barr Ferree (A & B–March 9.) 3000 w.

29971. Wrought-Iron Work in Charleston, S. C. From the Charleston Sunday News (A A –March 9) 1700 w.

29972. The Value of Sentiment. Address of Col. Henry Lee in Favor of the Preservation of the Boston State-house (A A–March 9.) 3000 w.

*29978. Malmesbury Abbey. Ill. R. W. P. (B–March 2.) 3000 w.

*30021. Uninhabitable and Unsanitary Houses. William Stevenson (A L–March 1.) 3500 w.

*30023. Design and Materials. P. Morley Horder (B A–March 1.) 1700 w.

*30024. Hotel Designing. W. Hamilton Beattie (B A–March 1.) 1000 w.

*30029. Rules to Be Observed in Planning and Fitting Up Public Elementary Schools (I C B–March 1.) 3000 w.

*30030. The Architecture of Theatres. Anon. (I C B–March 1.) 900 w.

30120. Mortar—How and How Not to Prepare It. Edward Wolff (Eng–March 16.) 1500 w.

30127. An Architectural License Law Should Be Passed. Letters from Warren R. Briggs and William T. Hallett (A & B–March 16) 2800 w.

30131. The Mercantile Club House in Philadelphia Ill. (E R–March 16.) 2800 w.

*30161. The Perspective of Buildings. From the Building News (I C B–March 8.) 2000 w.

*30163. Natural and Artificial Marble. Anon. (I C B–March 8.) 2300 w.

*30164. Stucco. Anon. (I C B–March 8. 1400 w.

*30174. Plaster Work. (Extract.) F. W. Pomeroy (B–March 9.) 2700 w.

*30206. The Late Hyde Clarke on Color (A L–March 8.) 3500 w.

*30209 On the Painting of Stucco. William Fourniss (Pl D–March.) 1200 w.

*30211. The Mediæval Glazier. (Extract.) Lewis F. Day (Pl D–March.) 1800 w.

*30213. Some English Cathedrals. (Extract.) Alfred Darbishire (B A–March 8.) 700 w.

*30237. Granites of Germany, France and Belgium. (Extract.) Hjalmar Lundbohm (S–March.) 2500 w.

*30238. Sioux Falls Jasper Granite. Ill. Anon. (S–March.) 1500 w.

*30239. The Slate Roof. G. B. Benford (S–March.) 1600 w.

30329. The New Lien Law of New Jersey. Full Text. (A & B–March 23.) 1300 w.

30337. Bramante and St. Peter's. H. Mereu (A A–March 23) 2700 w.

†30353. The Point of Departure Between Classic and Mediæval Architecture. Ill. P. B. Wight (I A–March.) 3200 w.

*30390. John Bernard Fischer. Anon. (A L–March 15.) 2300 w.

*30391. Some Principles Underlying Domestic Architecture. (Extract.) R. Barry Parker (A L–March 15.) 5300 w.

*30416. Building Construction in Its Relation to Fire Protection. Editorial (Can A–March.) 1800 w.

*30417. Paper on "English Methods." Frank Baker (Can A–March.) 2400 w

*30418. Points on Acoustics. David Gunn Baxter (Can A–March.) 1600 w.

*30419. A Chapter from My Note Book.—Building Methods in Rome. M. B. Aylesworth (Can A–March.) 4500 w.

*30420. The Æsthetic Unity of the Fine Arts.—More Especially in Relation to Architecture. Hamilton MacCarthy (Can A–March.) 4000 w.

*30421. Building Laws of Roanoke, Va. (S A–March.) 600 w.

*30422. Government Architects.—A Comparison of Their Work With That of the Profession. C. H Read, Jr. (S A–March.) 2800 w.

*30423. A Suggestion for Popular Education in Architecture. Editorial (S A–March.) 2400 w.

*30424. Beams and Girders and Their Relation to Structural Architecture. Ill. J. G. Longstreet (S A–March.) 2000 w.

*30425. Coloring Outside Woodwork. Editorial (I C B–March 15.) 700 w.

*30426. Bricks and Brickwork. Anon. (I C B–March 15.) 1500 w.

*30428. Common Sense in Building. Anon. (I C B–March 15.) 1200 w.

*30429. Painting a Room. By an Old Hand (I C B–March 15.) 1000 w.

*30491. Various Systems of Concrete Construction. Ross F. Tucker (B B–March.) 1500 w.

30503. Some Comparative Tests of Building Stones. Ill. Coles A. Raymond and Edward W. Cunningham (E N–March 28.) 3300 w.

30514. Is the Commission Basis the Proper Method of Estimating Architectural Services? Editorial (A & B–March 30.) 1200 w.

30516. Architectural Illustration. C. G. Harper (A & B–March 30.) 2500 w.

30519. Ramblings in Sherborne, Wilts, England. Sophia Beale (A A–March 30) 2800 w.

30523. The Ethics of Architectural Practice. From the N. Y. Evening Post (E R–March 30.) 1700 w.

30539. High Chimneys—Their Advantages, Economical and Sanitary. Ill. W. Barnet Le Van (M A–April.) 1500 w.

*30582. The American School of Architecture at Rome (A L–March 22.) 1500 w.

*30586. The Planning of Small Houses. T. W. F. Newton (B A–March 22.) 1100 w.

*30591. Comparisons and Contrasts in Architecture. (Abstract.) Banister Fletcher (B–March 23.) 1300 w.

*30592. Colored Decoration of Architecture. J. D. Crace (B–March 23.) 1800 w.

30687. Construction of a House of Constant Temperature. Ill. From La Nature (Sc A S–April 6.) 1000 w.

30716. The Underpinning of the High Court Building, Calcutta, India. Ill. Abstract from report of Charles Warde (E N–April 4.) 600 w.

30742. The March Grand Jury's Recommendations as to the New York Building Department, with Editorial (A & B–April 6.) 1400 w.

*30768. New Methods and New Materials (B A–March 29.) 1000 w.

30804. The Boston Public Library (A A–April 6.) 1700 w.

*30814. Terra Cotta. Anon. (I C B–March 29.) 1200 w.

Serials.

12568. Building Construction and Superintendence. Ill. F. E. Kidder (A & B–Began May 6, 1893—41 parts to date—15 cts. each).

18737. The Engineering of Architectural and Building Construction. William H. Burr (E R–Began Jan. 6, 1894—10 parts to date—15 cts. each).

18857. Electrical Science for Architects. Ill. Russell Robb (A A–Began Jan. 13, 1894—9 parts to date—15 cts. each).

19078. Problems in Stone Cutting. Ill. Ed. W. Hind (S–Began Jan., 1894—12 parts to date—30 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (B B–Began Jan., 1894—15 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (Pl D–Began March, 1894—12 parts to date—30 cts. each).

21288. Theatres. Ill. E. A. E. Woodrow (A A–Began April 14, 1894—14 parts to date—15 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (B B–Began April, 1894—11 parts to date—30 cts. each).

26069. Modern Steel Fireproof Construction. Ill. F. M. Small (A & B–Began Oct. 13—5 parts to date—15 cts. each).

26070. The Planning and Construction of American Theatres. Ill. William H. Birkmire (A & B–Began Oct. 13, 1894—6 parts to date—15 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (A & B–Began Nov. 24, 1894—5 parts to date—15 cts. each).

28494. Bricks and Terra Cotta (B–Began Jan. 5—11 parts to date—30 cts. each).

28805. Fireproof Floor Arches. Ill. George Hill (B B–Began Jan.—3 parts to date—30 cts. each).

29200. The Advancement of Architecture. Professor Aitchison (B–Began Feb. 2—6 parts to date—30 cts. each).

29253. The Guilds of the Medieval Workers in Stone. Edward C. Weaver (S–Began Feb.—2 parts to date—30 cts. each).

29358. Hints to Art Students on Travelling Abroad. J. W. Case (A A–Began Feb. 16—4 parts to date—15 cts. each).

29581. Ornamental Iron Arches. Ill. Archie (B B–Began Feb.—2 parts to date—30 cts. each).

29969. The Tenth League Exhibition. Anon. (A A–Began March 9—2 parts to date—15 cts. each.

30589. St. Sophia, Constantinople. Ill. (B–Began March 23—Ended March 30—2 parts—30 cts. each).

30812. The "Sky Scraper." F. C. Gordon (I C B–Began March 29—1 part to date—30 cts).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

The Santa Ana Irrigation Canal.

An abstract of a paper by Mr. Ham Hall (read Feb. 5 before the American Society of Civil Engineers) in the *Railroad Gazette* (March 29) presents some interesting facts relative to irrigation practice in California. The canal is designed to take water from the Santa Ana river for irrigating 45,000 acres of land in the northern portion of San Jacinto plateau, the supply being "reinforced, when necessary, by water from a storage reservoir in the San Bernardino mountains, impounded during the flood period."

Only divisions I and II are discussed in the paper, these portions being now completed to about one-half capacity. A remarkable feature of the work is the tunneling involved in it. "Nine mountain spurs are pierced by tunnels, whose aggregate length is 4329 ft. Three large transverse cañons are crossed by pressure pipes, with a total length of 2127 ft.; nine reaches of flume have an aggregate length of 11,394 ft.; one piece of walled canal has a length of 152 ft.; and eight masonry structures cover 173 ft. in length of line. There are thirty-nine substructures, consisting of girders or combination Fink truss spans, with an aggregate length of 1905 ft."

"In division II, as now finished, there are eight stretches of canal, with a total length of 8214 ft., nearly all lined with rubble in mortar. There are seven reaches of flume, aggregating 2706 ft., crossing six gulches and the wide torrent-bed of Mill creek. The gulch crossings are supported by string girders and wooden piers on masonry footings, with an aggregate length of 1440 ft., and Mill creek crossing is made by a riveted steel bridge 1072 ft. long."

"Of the nine tunnels in division I eight are through rock, and were driven by contract. The ninth, through cemented gravel and boulders, was driven by day labor. The specifications under which contracts were let provided that the contractor should furnish all the material, tools, and outfit, except the lumber for lagging and timbering. All tunnels were uniform in cross section, provision being made for variation in excavated section where timbering would make it necessary."

In tunnel No. 9, which is 510 ft. long and was subject to air-slacking, a "special experiment in the use of wood lining was introduced. The lining is made of 3-in. redwood staves, pressed into place and held within a shell formed by ramming concrete as backing into a space between the staves and the face of the tunnel bore. To preserve the wood this tunnel is located more than its diameter below the grade, so that, no matter how little may be running, the staves remain always thoroughly soaked. The lining was built in lengths of 8 to 14 ft. each. The staves of the succeeding lengths were broken-jointed, with an end lap of 4 in., and the end joints were made between each two abutting staves, with a metal tongue taken into a saw kerf in the staves' ends. The staves were a little less than 8 in. wide, with the edges milled to radial lines of the circle, and with a ⅛-in. bead on each edge one third the thickness from one side. The entire tunnel proper will be under a pressure head of between 1 and 3 ft. at its top plane when there is any water whatever running in the aqueduct, and between 7.3 ft. and 9.3 ft. when the full 240 second-feet are flowing. At the up stream end it flares in 16 ft. of length to an oval, having horizontal and vertical axes of 114 and 72 in. respectively. This was done to receive, with the least disturbance of current, the water from two 52-in. pressure pipes laid side by side and 6 in. apart. There is a gateway provided at the down-stream portal to close it sufficiently to always keep the wood lining of the down-stream extension wet, no matter how little water may be running."

"Calking was resorted to whenever there was any indication that a seam was not thoroughly closed. Such lining guards better against rupture by earthquakes than any other, and the planed wooden face diminishes friction and materially increases capacity. The wood lining cost $4.28 per linear foot, and the lining complete $8.11; the tunnel complete $12.64."

"The three pressure pipes of the line cross three cañons. They are pipes made of redwood staves, bound with round steel rods, with the end joints closed by metal tongues let into saw kerfs in the stave butts. They were used instead of iron or steel to save expense, and also because they could be laid wholly above ground and thus save cost of excavation and back filling, whereas, owing to the temperature, metal pipes would have required covering."

Great Tunnels of the World.

Mr. Robert Jamison, writing for the April number of *The Chautauquan*, thinks the burrowing of the common field mole suggested tunneling to the ancients; but why the mole, any more than the marmot or other burrowing animal, does not clearly appear. Whatever suggested tunneling, whether animal burrowing, or natural tunnels or caverns, it is quite certain that artificial tunneling for the service of man is of very ancient date. Rock-cutting and earth-excavation are among the oldest of arts. The catacombs at Rome and the Indian temples wrought from solid rock are illustrations of this assertion. The rock-cutting and earth-excavation of the present era are incomparably more rapid than the laborious processes of the ancients; and the comparative ease with which this sort of engineering work can now be performed through the use of compressed-air rock-drills, steam and electric rock-drills, and the employment of high explosives, renders almost any reasonable scheme of tunneling or excavation acceptable in plans for great railroads, or even for ship canals. In fact, if our memory serves us, a famous engineer once said he would undertake to tunnel straight through the earth from New York to Pekin, if anybody would furnish capital for the enterprise.

Mr. Jamison has compiled some interesting facts anent the famous tunnels of the world. "There are to-day over one thousand tunnels on the lines of the world's railroads." It is only about 25 years since tunneling was all done with hand-drills and gunpowder blasting. With improved methods and railway extension, tunnels miles in length have come to be not infrequent. The great Simplon tunnel, when completed, will be 11 miles in length. Tunnels of from 3000 to 7000 ft. "were once considered as important." They are now only commonplace. "The first really great railroad tunnel was The Hoosac. Projected in 1854, it was not finished till 1876, after 22 years of labor, delays, failures, and final success. This, the first of the great quartet of mountain tunnels, is 4¾ miles long and cost $10,000,000, or $379 a running foot. The two mountains under which the Hoosac passes are 2504 ft. and 2212 ft. above the sea level, and there is a deep valley between them. In this valley a shaft was sunk 1028 ft., and headings were cut in both directions from the bottom of the shaft. This made it possible to work in four directions at once. The highest peak of the mountain is 1700 ft. above the floor of the tunnel. The rock through which the tunnel is cut varied somewhat in strength, and the softer and weaker parts are lined with masonry. From the commencement of the work in 1856, including delays, up to 1866, all the drilling was done by hand. Then the compressed-air rock-drill came into practical use, and the building of great tunnels rose to the dignity of a great science."

The length of a tunnel, within reasonable limits, is no longer a serious difficulty. Neither is it very difficult to supply light and air to long tunnels. The electric light and the modern pneumatic appliances have reduced these old-time difficulties almost to zero.

The author intimates that the long-mooted tunnel under the English channel would have been a fact before this time, were it not that "Englishmen and Frenchmen are so ignorant of each other that they are afraid to shake hands under the sea." Some might think, however, that a better reason for such a fear is that ancient feuds have made them too well acquainted with each other's tricks and manners to unite in such a scheme.

"Of the quartet of great tunnels—Hoosac, Mont Cenis, St. Gothard, and Arlberg — the first only was built absolutely without thought of its political significance or military value. Mont Cenis is a gateway in the boundary line between Germany and Italy, and Arlberg is still a different gate in the great mountain barrier between these nations. The value of these great tunnels between nations is in large degree dependent on this very fact. They unite one great power with other great powers. No single railroad company could build them; perhaps no single nation could or would undertake their construction. Combinations of nations alone could carry out such enormously costly undertakings. Grouped together for comparison, we find that Mont Cenis, 7⅝ miles long, cost $15,000,000; St. Gothard, 9¼ miles long, cost $11,175,000; and Arlberg, 6⅜ miles long, cost $7,300,000. It took 14 years to build Mont Cenis, 9 years to build St. Gothard, and 5 years to build Arlberg. From the start these great tunnels employed power drills and every possible aid and appliance of modern science. They are indeed the great engineering works of the world."

The tunnel under the Thames river is the first important sub-aqueous tunnel. It was projected in 1798 and completed in 1843. It is a mere baby to what has since been done in this line. The tunnel under the St. Clair, 6050 ft. long; that under the Severn, a little over 4 miles long; the Mersey tunnel, 23,615 ft. long,—each affording passage for great railways,—dwarf the Thames tunnel (in its day considered a great achievement) into utter insignificance. The Hudson river tunnel, if it ever be completed, will take rank among the greatest sub-aqueous tunnels of the globe.

The great Sutro tunnel at the Comstock Lode is probably the most important of all mining tunnels, though hosts of other mining tunnels might be named. If all the tunnels existing could be strung together in a direct line through the earth from New York to Pekin, as was facetiously proposed, they would reach through a notable fraction of that shortest line between these cities.

Masonry Dams.

THE ENGINEER (London, Feb. 2) gives editorially a caution against too firm a reliance upon mathematical results in computations, except where the constants employed are all experimentally and thoroughly established. When any assumption of a constant is made without experimental determination, a mathematical computation may lead to very inaccurate results. The editorial then proceeds to point out that just such assumptions enter into mathematical calculations in the designing of masonry dams. For instance, in the matter of elasticity of masonry and of mortar the modulus of elasticity is assumed as constant, whereas Sir Benjamin Baker found it to vary for both materials from one to five. And this modulus varies in the same specimen with the values of the stresses put upon it, so that our contemporary thinks that "of all misnomers that of 'constant' applied in the manner indicated is most flagrant." The analytical methods of the French engineers, followed up in England by Rankine, have evolved "a form of high masonry dams far superior to the old or trapezoidal type."

"With the same margin of stress, the latter form required twice the quantity of material, which is probably the reason some of them have stood very well. Nevertheless, the necessity for employing a section of minimum area and of correct form is obvious, and not only on the score of economy, but of security also. A mass of masonry built in the wrong place in a dam is equally productive of disastrous consequences as would be a large quantity of material erroneously located in the design of a bridge, roof, or any engineering structure. In fact, many instances have occurred in which dams designed upon the old principle have completely collapsed. As they were most of them of the trapezoidal form, the failure could not be traced to an insufficiency of material, but was unquestionably due to an irregular and faulty distribution of it A good deal of discussion and comment has been called out by the assertion that the so-called Rankine's section of a dam is wasteful of material. Taking into consideration the pros and cons on the question, which include the opinions of some of our most eminent engineers, we are disposed to think that the statement is not entirely without foundation. We do not endorse the statement which has been made that, in adopting Rankine's section, the redundancy of the cross sectional area reaches the exorbitant proportion of 43 per cent., because the assertion is incorrect, although at the same time, curiously enough, it is in one sense true. This apparent paradox needs some explanation. It is true that, by applying the section in question to a dam of moderate height, the excess of material would be fairly represented in the upper portion by that percentage; but Rankine not only never intended that his section should be of universal application to any height of dam, but expressly stated so He, in fact, pointed out that the section was not suitable for dams of less than a certain height, and demonstrated the correct method for making a corresponding reduction in the section. So far, so good; but it does not appear to be controverted that even in adapting his section to high dams, for which it was originally intended, there does result a certain waste of material, although not to any extent approaching the amount erroneously attributed to it when employed on a small scale."

In view of all this, and "granting for the sake of argument" that the form of the modern dam is more economical, it is concluded that this is not a reason why "a somewhat differently proportioned and contoured section may not have equal stability, and afford equal security against accidents. While due regard should be had to economy in the design and construction of all engineering undertakings, yet, in consideration of the enormous interests involved in the safety of a structure like the Vrynwy dam, there are some questions that should take precedence over all others." Neglect to properly consider the length of the maximum section as well as its height, on account of the greater attention the latter demands, is charged as being sometimes a fault in designing. For instance, such a dam as the Vrynwy, which has a maximum section extending over a length of 600 ft., receives no lateral support from the wings; and it is thus concluded that a section suitable for a narrow gorge might be wholly unfitted for a wide dam like the Vrynwy.

The Manchester Ship Canal.

THE half-yearly meeting of the stockholders of the Manchester Ship Canal Company does not appear to have been altogether a love-feast. Some caustic speeches were made, and *Transport*, which gives an account of the meeting, says "it is evident that the directors have come nearly to the end of their tether." The ordinary shareholder finds himself in the position usually attending the threatened financial collapse of corporate enterprise. *Transport* thinks that perhaps something may be hoped for from the patriotism of the citizens of Manchester, which may prove sufficient to save the undertaking from utter failure; but, if this prove to be a correct prognosis, it will not help the present shareholding interest. "The inevitable crash can neither be averted nor postponed for any length of time."

This outcome is not a surprise to those who have carefully observed the management of the company's affairs. "It has long been evident to all who followed closely and intelligently the financial and commercial outlook that the canal was a foredoomed failure. Misleading estimates as to capitalization, misleading estimates as to traffic and revenue, have filled the public with disgust, and overwhelmed the project in certain disaster. It is idle, it is simply begging the question, to say that such a conclusion is premature. What hope is there that next year's result will be materially better than the one which has just closed? Such platitudes as that new enterprises expand slowly, that the avenues of commerce are difficult to change, and that competing interests fight bitterly to hold their own, can deceive nobody now. The voice of the enchanter has lost its magic power. The spell of the magician is gone. It is harder to attract a few thousand tons of traffic than to draw millions from the pockets of the confiding investor. The canal authorities never concealed their light under a bushel. The waterway was opened with all the pomp that royalty could give, and Lancashire turned out in millions to rejoice in the event. Such was the general enthusiasm pervading all classes, from the highest to the lowest, that it may be safely assumed that whatever business men could give in the way of trade was given with no niggardly and stinting hand; but they could not be expected to make great personal sacrifices to inaugurate a brief period of inflated prosperity for an enterprise which they must have seen could never exist on a stable basis."

The statement that the enterprise has suffered through misrepresentations of interests affected adversely is characterized as "simply childish." The plain facts appear to be that a great engineering work has failed to be remunerative, and that this is largely due to its mismanagement. The cost of the entire work has been £15,000,000, or more than double the original estimate, and the traffic estimates of the manager have been as gravely inaccurate as those of the engineers.

"At the present time the annual obligations of the company amount to £331,280. The receipts on the revenue account amounted to £53,593, and the working expenses to £42,595, showing a balance of £10,998. Add to this the profits of working the Bridgewater canal, and the total is brought to £36,870. Up to the present, interest on the existing obligations has been met by the accumulated profits of the Bridgewater undertaking; but the unapplied balance has now been reduced to £34,700, so it is clear that fund will no longer be available."

It is hoped the lesson of this enterprise may not be lost upon American investors. Ship-canal schemes are now as plenty as blackberries on this side of the water, but somehow most of them do not seem to progress very much beyond the scheme stage. It is, however, not improbable that, when prosperous times return, some of them will get launched. The lesson of the great Manchester ship canal ought to teach the dangers incurred in this class of investments.

A New Darien Ship-Canal Route.

ITEMS relating to a new canal route across the Isthmus of Darien having of late been current in the daily press, *Engineering News* (March 4) obtained the particulars of the scheme and published them in connection with a map of the route herewith reproduced. It is stated that this route has been discovered by Mr. Gustavus A. Karwiese, who claims to have been investigating ship-canal routes in Central and South America for the last 28 years and to have "made personally eight instrumental surveys of the route under consideration." The only material available for forming a judgment of the feasibility of the route are the map and the statements of Mr. Karweise, whose estimates are based upon confessedly incomplete data.

The proposed route is from the Gulf of Darien to the Bay of San Miguel, through the State of Columbia and south of the Panama Canal concessions. "Mr. Harweise says that, commencing on the Pacific side, there are about 11 miles of free navigation up to the Bay of San Miguel and the Tura river, and he proposes to dredge out and rectify the remaining part of this river up to the point H, on the map, where he locates his first tidal lock, about 60 miles from the Pacific, along the present crooked course of the river and bay. He claims that there is 38 ft. of water for about 11 miles of this line, and that over the remainder dredging is easy.

"He commences what he calls his canal proper at the point H, and follows the Javiesa river and valley until the main ridge of the Cordilleras is reached at T, where he proposes a tunnel 11,880 ft. long through the mountain. His canal terminates between Capes Acanti and Tolo, on the Gulf of Darien, in a naturally protected harbor. The length of this section he fixes at 28⅝ miles, that is, from the lock at the point H to the Darien entrance lock at B· And from the Pacific ocean to the gulf the distance would be about 93½ miles, on the line described."

"The summit of the Cordilleras at the point tunneled is 1180 ft. above the sea level, and, as he proposes a tunnel 88 ft. wide and 112 ft. high, this would leave nearly 1000 ft. of solid rock over the crown of the tunnel. For the 28⅝ miles of canal excavation he proposes a width of 88 ft. and a depth of 28 ft. 8 in. He estimates that this would allow two ordinary ships to pass each other. For the river course on the west he plans a width sufficient for the passsage of four ships abreast, but does not give exact dimensions." The cost of the tunnel he estimates as $11,000,000, though he asserts that Chicago contractors have estimated it at $8,000,000; and he places the cost of the completed canal at $48,000,000, which certainly is cheap in comparison with the cost of proposed canals on other routes. Other particulars are given, but the main outlines of the scheme are as stated.

Irrigation in Colorado.

UNDER the title "Colorado as a Grain-Producing State" *Milling* (Feb.) discusses, the progress of irrigation in that State especially, and incidentally the general progress in cultivation by irrigation throughout the arid regions of the west. In Colorado, "within the past few years large tracts of land, otherwise worthless, have been rendered available for farming purposes" by irrigation. By means of canals and ditches "hundreds of thousands of acres are now producing crops calculated to astonish any Mississippi valley farmer. Denver, Longmont, Boulder, Fort Collins, Greeley, and Pueblo have come to be surrounded with productive farms and gardens. The average yield of wheat in Colorado is from 20 to 25 bushels to the acre, but is often 40 bushels and over. This is about double the product obtained in many of the great wheat-growing States."

Our contemporary, after noting the general interest in the subject of irrigation, states that recently "some of the citizens of the western counties in Colorado sent a striking petition to their senator and representatives at Washington. They called attention to the fact that a splendid tract of land, comprising 1,000,000 acres in western Colorado and eastern Utah, is susceptible of irrigation by the waters of the Grand river, and that it would cost about $5 per acre to make this fit for settlement. They urged the government to immediately undertake the reclamation of this immense tract, thus giving employment to a large number of idle men, and making homes for tens of thousands of now landless and homeless families. They pointed out that the government would quickly receive its money back from the settlers, and would thus only temporarily advance the capital required for work. Here are 1,000,000 acres, now desolate and worthless; here is a good river, pouring uselessly to the tropic sea. Marry that water to that land, and lo! the voiceless desert will blossom with the homes of men! The desert of to-day will be the garden of to-morrow, for the soil is rich beyond comparison, and the climate is favorable to an extraordinary degree."

There is a wide and growing field in the great west for engineers expert in the science and art of irrigation. Repairs of engineering works will soon largely supplement new construction, and altogether there is now scarcely a more promising specialty than irrigation in the whole range of civil engineering.

A CIRCULAR forwarded to us by Mr. John C. Trautwine, Jr., secretary of the Association of Engineering Societies, announces that the Technical Society of the Pacific Coast has recently become a member of the association, making now a total membership of eleven societies. The *Journal of the Association of Engineering Societies* always contains valuable papers, and in the course of a year a wide field of engineering topics is thus covered. A well-prepared monthly index of current engineering literature is a feature.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Bridges.

30062. The Proposed Great Suspension Bridge over the Hudson River, New York City. Ill. (Sc A–March 16.) 600 w.

30129. Hudson River Bridge Specifications (E R–March 16.) 3500 w.

30314. Diagram of Comparative Weights of Railway Bridges. Prepared by H. Breen (E N–March 21.) 450 w.

30612. Ballast Floor Bridge, Michigan Central Railroad, Delhi, Mich. Ill. (R R–March 30.) 800 w.

30714. Concrete and Steel Wire Floor, Lincoln Park Bridge, Chicago. Ill. (E N–April 4.) 600 w.

30718. Cofferdams Used at the Queen's Bridge, Melbourne, Australia. (Abstract.) W. R. Rennick (E N–April 4.) 1800 w.

30762. Notes on the Field Inspection of Bridges. Harold Jeans (R G–April 5.) 1600 w.

30763. The New Delaware River Bridge of the Pennsylvania Ill. (R G–April 5.) 1200 w.

Canals, Rivers and Harbors.

30066. The North Baltic Canal (E & C–March 8.) 800 w.

30104. A New Darien Ship-Canal Route. Ill. Discovered by Gustavus A. Karwiese (E N–March 14.) 700 w.

30108. New Masonry Dam at Lonsdale, R. I.—Combination of Dam and Railway Bridge. Ill. (E N–March 14.) 600 w.

*30259. Manchester Management and Misleading Estimates (Tr–March 8.) 1800 w.

30497. Improvements of the Harbor at Seattle. Ill. (R G–March 29.) 1500 w.

30504. The Canadian Ship Canal Lock at Sault Ste. Marie, Ont. Ill. (E N-March 28.) 3600 w.

30546. The Monongahela River.—Its Importance, Commerce, &c. Ill. (A M & I W–March 29.) 15800 w.

30681. Proposed Steel Lift Locks at Lockport, N. Y., with Editorial. Ill. (Sea–April 4.) 3000 w.

30712. Concerning the Nicaragua Canal and Darien Canal Routes. Editorial (E N–April 4.) 700 w.

30713. Concerning Darien Ship-Canal Routes. Letter from Thomas Wright Hurst (E N–April 4.) 700 w.

Hydraulics.

30128. The Great Falls, Mont. Water Power. Ill. (E R–March 16.) 1700 w.

*30178. The Drainage of the Haarlem Meer. Ill. Anon. (E–March 8.) 1000 w.

30455.—$1.50. The Halsted Street Lift Bridge. Ill. J. A. L. Waddell, with Discussion (T C E–Jan.) 23800 w.

Irrigation.

*30147. The Nile. Colin Scott-Moncrieff (N–March 7.) 7500 w.

*30232. Colorado as a Grain-Producing State. Ill. Anon. (Mill–Feb.) 1000 w.

30500. The Santa Ana Irrigation Canal. (Abstract.) William Ham. Hall (R G-March 29.) 1000 w.

*30667. Centrifugal Pumping from Pits in California. Ill. Byron Jackson (I S F–April.) 1500 w.

30700. Riparian Ownership.— Decision of Supreme Court of California (E & C–March 29.) 2200 w.

Miscellany.

*29820. Masonry Dams. Editorial (Eng L–Feb. 22.) 2500 w.

*29957. How Holland Was Made. Ill. Foster Crowell (C E Mag.–May.) 3000 w.

29976. Recent Highway Work in Vermont (E R–March 9.) 2000 w.

*29984. Tequixquiac Tunnel for the Drainage of Mexico. Anon. (E–March 1.) 3600 w.

30011. Brock Street Tunnel, Montreal. Ill. (C Eng–March.) 1000 w.

30111. The Use of Cheap Local Materials for Improving Country Roads (E N–March 14.) 1200 w.

*30295. Riparian Ownership of Lands Bordering on Lakes and Rivers. J. H. Armstrong (J A E S–Feb.) 3300 w.

*30367. The Blankenberghe Pier, Belgium. Ill. (Eng L–March 15.) 2500 w.

*30374. The Great Tunnels of the World. Robert Jamison (Ch–April.) 4000 w.

*30490. Adulteration of Portland Cements. William C. Hartranft (B B–March.) 900 w.

†30532. Influence of the Size of Grain on the Strength of Cement (I Eng–Feb. 23.) 500 w.

30710. Concrete Well Monolithic Dock Foundations at Newcastle, Eng. (E N–April 4.) 900 w.

30711. The Ransome System of Monolithic Concrete Conduit Construction. Ill. (E N–April 4.) 1300 w.

30736. Measurement of Water. A. M. Ryon (E R–April 6.) 3000 w.

*30748. Maximum Moments and Shears in Trusses Having Parallel Chords by Graphics. Malverd A. Howe (E M–April.) 800 w.

Serials.

28662. Practical Bridge and Girder Construction. Ill. Anon. (M W–Began Jan. 18—3 parts to date—30 cts. each).

28495. The Blackwall Tunnel. Ill. (E–Began Jan. 4—5 parts to date—30 cts. each).

28498. Thames Bridges. Ill. Anon. (E–Began Jan. 4—7 parts to date—30 cts. each).

30177. Irrigation in Peru. Ill. Anon. (E–Began March 8 –2 parts to date—30 cts. each).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Sanitary Fixtures and Fixing.

UNDER this title *The British Architect* prints an abstract of a paper recently read by Mr. Paul Gerhardt, dealing with both defective and improved appliances in modern plumbing. There is no waste of eloquence in this article, and only a few of the topics indicative of its scope can be touched upon in this review. The modern practice of architects, in confining plumbing work to kitchen, bath, pantry, and laundry, instead of scattering it all over the house, as was formerly the practice is first commended, and then the author says:

"There is one mistake, however, which is still frequently permitted. This is the placing of the water-closet in the same room where the bath-tub, or the wash-basin, is located. This is objectionable on æsthetic as well as on practical grounds. It is particularly so in the case of the smaller houses, and in apartment houses, with only one bath-room. In more elaborate houses of rich people, where there are several bath-rooms, the separation of the water-closet is not so necessary for practical reasons; but I think that a bath-room with a water-closet can, in all cases, be made much more inviting by contriving an ornamental screen, or a low partition separating the water-closet from the other fixtures. The partition may be lined with marble or tiling, and its upper part may be constructed of open fretwork."

Pan-closets, plunger closets, and valve closets are stated to have gone, or to be going, out of use. Improved water-closet troughs have taken the place of the former privy sink. Wooden laundry tubs have been replaced by better tubs of non-absorbent material. The variety of sanitary fixtures now in market is very large. Among them, Mr. Gerhardt disapproves wash-out closets, though he does not severely condemn them, preferring flush-rim long hoppers, pedestal short hoppers, siphon and siphon-jet closets, or wash-down closets having vigorous and direct flush. Wash-outs are, however, popular at the present time, though this writer does not regard them as the equals of those above named. "Two points require careful attention, where porcelain water-closets are used. One is the floor-joint, which, being on the sewer side of the water-closet trap, must be made tight. The other is the connection between the piping and the earthenware horns of the bowl. If these are made rigid, breakage of the earthenware is the result of the slightest settlement of the floor. A flexible connection is, therefore, much to be preferred, and can now be obtained with many of the types of closets named."

Enameled iron tubs and porcelain tubs are rapidly replacing copper-lined wooden tubs for bath-rooms. The wooden glazed roll rim does away with all need of the undesirable woodwork. Wash-basins include tip-up basins, tie-up basins, chain-and-plug basins, and secret waste-valve basins. Tie-ups and chain-and-plug basins are condemned. The receivers of the tip-ups are stated to get foul, yet credit is given to some modern styles of tip-up basins which are considered as great improvements upon former styles. The open stand-pipe over-flow basin is, for sanitary reasons, preferred by Mr. Gerhardt to any other form now in use; but "the general public is hardly sufficiently educated in sanitary matters to appreciate its merits. By many this form of basin is utterly condemned on account of its odd shape and appearance. The favorite form of basin is just the one which has the most objections from the hygienic standpoint,—namely, the bowl with secret waste-valve." Slop-sinks and house-maids' sinks "are obtainable in a variety of serviceable forms, most of them excellent from the sanitarian's point of view." The avoidance of wood-work at and around plumbing fixtures is a point specially emphasized.

Greenhouse-Heating.

A. H. Dudley, in *Heating and Ventilation* (March 15), refers to the fact that greenhouse-heating is generally a specialty in the heating trade, and he writes with the purpose of enlightening steam and hot-water fitters who have had little or no experience in this sort of heating work. Whether steam or hot water will be the better for any particular greenhouse will depend wholly upon "the conditions under which the plant will be run." The florist who desires to order an apparatus for greenhouse-heating will be likely to have very clear and positive ideas upon this point, and they will be based upon the following considerations. "With steam the temperature of a greenhouse may be quickly raised or lowered, whereas with hot water this takes some time, owing to the larger volume of water in the system. On the other hand, the slowness in lowering the temperature with hot water is often of the greatest value to the florist; for, should the fire go out in the heater during the night, the large volume of water in the system will continue to give off its heat several hours thereafter, thus keeping the plants from being injured by the drop in the temperature which would follow under similar conditions if steam were used. It is also often claimed for hot water that the temperature in a greenhouse may be much better regulated during comparatively mild weather than it can with steam," but with a steam system properly designed temperature may be as easily controlled as with hot water.

Any calculation of heating capacity based upon cubic contents of a greenhouse would be generally faulty in the extreme. The entire equivalent of glass exposure in square feet, including sides, ends, and overhead glass, should be determined carefully, and the "sides and end walls, if of wood sheathed and papered good and tight, should be figured in the following proportion,—*viz.*, 5 sq. ft. of wall to 1 sq. ft. of glass." After getting the number of total square feet of glass and equivalent, the next point is the proper amount of heating surface necessary. This is dependent upon the temperature required, which must be determined by the florist, as the temperatures of greenhouses vary from 35° to 70° F., according to the stock which is to be grown.

The following is given as a safe rule for determining the proportion of heating surface to glass surface for various temperatures in the greenhouse, when the outside temperature is at zero. with no more than 5 lbs. of steam pressure at the boiler. For maintaining a temperature of 40° F. in a greenhouse, 1 sq. ft., of heating surface to every 9 sq. ft. of glass or its equivalent will be needed with steam at the pressure named; and, for each increase of 5° F. to be maintained above 40° F., until 55° F. is reached, the amount of glass for which 1 sq. ft. of heating surface will suffice must be decreased 1 sq. ft.; and thereafter, for every increase of internal temperature of 5° F., the amount of glass for which 1 sq. ft. of glass is sufficient is decreased by 1/2 sq. ft., till a temperature of 70° F. is reached. This rule could not, however, be applicable for all climates, and the author does not give any directions for modifying either for colder localities, or for warmer ones where the Fahrenheit zero of temperature is never reached. The remainder of the article deals with arrangement of pipes and distribution of heat, which topics are illustrated with diagrams, making a good study in modern heating practice for greenhouses and conservatories.

A Garden-Sculpture Exhibition.

It is announced in *Garden and Forest* (March 20) that during the present month (May) there will be held in New York an exhibition of garden-sculpture, the purpose being to stimulate and improve a taste for sculpture in landscape gardening. Mr. N. F. Barrett, landscape engineer, and Mr. Thomas Hastings, of the firm of Carrère and Hastings, architects, have been put in charge of designs for the arrangement of the galleries. The plants needed in their schemes will be supplied by a firm of florists, the underlying idea being to show "the possibilities of combining sculpture with flowers and plants in both natural and formal gardening and interior decorations."

The place where this exhibition will be held will, doubtless, be duly announced in the daily press. We understand that at the time *Garden and Forest* made the announcement a suitable place had not been engaged. The enterprise was initiated and will be carried out under the auspices of the National Sculpture Society, which has issued a circular stating the aims desired and results hoped for. It is the belief—expressed in the circular referred to—that the proposed exhibition will "encourage a larger use of sculpture in the embellishment of the villas and houses of America, and give a new and powerful impulse to the production of ideal sculpture throughout the nation."

There is much doubt whether the exhibition will or can prove successful as an example of effects obtainable in landscape-gardening through the aid of sculpture. Our contemporary speaks of the project as follows: "Fully to display the sculptor's decorative power, formal gardening schemes need great avenues of trees and great stretches of water, giving room for the introduction of stately or graceful figures in symmetrical array, for noble lengths of balustrading, and fountains of monumental size. Nothing of the sort could, of course, be attempted within four walls, even were the vast interior of the Madison Square Garden to be the chosen area, and even did all horticulturists in America contribute of their products. And with regard to naturalistic schemes the case is similar. In such schemes the sculptor can never play a dominant part, as he may in certain portions of formal schemes, and even his part as a docile assistant is rather narrowly limited, and should be played with the greatest care and discretion. Nothing is more certain to injure a naturalistic gardening scheme of broad character than the presence of the smallest piece of sculpture inappropriately placed; and, as the Parc Monceau, in Paris, proves, even Frenchmen have conspicuously sinned in this respect, admirably though they use works of sculpture in more formal pleasure-grounds, like the Luxembourg and the Tuileries gardens. We note with regret that the Sculpture Society's circular speaks of its exhibition as including 'an exhibition of landscape-gardening.' In art, as in everything else, it is important that words be used with precision, lest confusion of thought arise from verbal inaccuracy; and it would be a very confused thought indeed that could picture the interior of an apartment transformed into any scene having a 'landscape' character. Landscape-gardening is one branch of the art; naturalistic gardening on a small scale is another, with quite different ideals to meet, as well as means to employ. No more than the latter branch, on its smallest scale, can be attempted in the coming exhibition, but, even so, right management will be still more difficult than will formal schemes."

The difficulties to be encountered are comprehensively set forth in the quotation. The National Sculpture Society may succeed in organizing a pleasant show of flowers and beautiful sculpture, but that this can include an exhibition of landscape-gardening, as announced in the circular, is clearly impossible.

Church-Heating Plants.

THAT a hot-water system of heating is not well adapted to buildings wherein the apparatus is not kept in continuous working from the beginning of cold weather until no longer needed in the spring has long been the contention of those not interested in the manufacture, sale, and erection of such apparatus. The risks to low-pressure steam-heating apparatus through intermittent action are less, but by no means *nil*, as is proved by an extract from an editorial in *The Metal Worker* (March 30), which says: "It is probable that the weather of the past winter made more extensive repairs necessary to church-heating systems than in any others; and whether the systems were steam, hot water, or combination, the effect was the same. The most severe effect of the weather coming at the middle of the week, many church-heating plants were without fire, no fire having been necessary during the previous portion of the season to prevent their freezing. On firing up late in the week for the next

Sunday the damage sustained was discovered, in many cases too late to be repaired in time for use on the following Sunday. In some hot-water jobs every radiator in connection with the plant was frozen and burst, and in some cases every section of the radiator. The damage was not confined to the radiator alone, but both the flow- and return-pipes and the fittings succumbed to the frost. In steam plants where the condensation did not return to the boiler, owing to poor piping or want of air valves, the plants were rendered unfit for service by ice bursting pipes and radiators. In churches where combination apparatus was used some difficulty was encountered in explaining that the water-heating apparatus would be ruined if the furnace was run, though in some cases the risk of its destruction was taken in order to have service. It requires more judgment than is possessed by the average sexton to say when the fire shall be run to prevent freezing, and the extra labor of emptying and filling the system, as a precaution, is seldom undertaken." Low-pressure steam heating, if properly put in, should not endanger steam radiators, whether direct or indirect, although indirect radiators require greater care in setting, and better valves to prevent the accumulation of water in them. If not set so that they will be well drained at all times, the cold air driving in through cold-air ducts is liable to freeze their contents and burst them when they are not in regular use. But care and proper construction of cold-air boxes, with dampers controlled by a thermostat, can be made a safeguard against such accidents. In any system of steam heating, if the water is not drawn off at times when the apparatus is not in use, the return-pipes in the cellar may be frozen at such times—provided the cellar is cold enough for frost—and burst in consequence, as not unfrequently happens.

Double-Boiler Plumbing Work.

In many cities—notably in parts of New York city—the hydrostatic pressure due to head is insufficient to supply water to floors higher than the first or second. In such buildings it has been a common practice to pump water up into a tank on the roof, whence it is drawn to supply the floors for which the pressure in the mains is inadequate. A modern method is known as the "double-boiler" system. This system, according to a writer signing himself "Grayson" in the *Sanitary Plumber* (March 15), "is resorted to in all cases for the purpose of avoiding the cost of pumping water to those fixtures which the street-pressure will supply without pumps. When water is pumped to tanks or roofs, the pipes and fixtures connected with the tanks are called the high-pressure system, in contradistinction with pipes and fixtures supplied directly from street mains. There are three general plans of arranging double-boiler jobs. One plan is to place one reservoir within another, and connect only the outside reservoir to the water-back in the range. The high-pressure supply is always connected to the inner reservoir in this style of work, and the water in the inner reservoir is heated by conduction of heat from the water in the space between the inner and outer reservoir walls. By this plan only enough room for one reservoir is required, and there is no cause for having two water-backs in the fire-box of the range, nor a secondary heater without," as is the case with another system described in the article. "In addition to a combination reservoir requiring the minimum of floor space, the cost of one water-back and one set of circulating pipes is saved. Whatever the material of the outside shell of a combination reservoir may be, the inside shell should be of copper.

"The second method of arranging a double-boiler job is to use two reservoirs of substantially the same type as is used in ordinary work, placed side by side, with space enough between them to stand a secondary heater. In this way but one water-back is necessary, as the connections for one reservoir are carried first to the secondary heater and then to the reservoir. The other reservoir is connected to the secondary heater in a manner similar to the ordinary strong connection, and its water absorbs heat from the water which circulates between the water-back and the other reservoir."

A third variety of double-boiler work is described and illustrated. Its exposition requires the use of a diagram on a scale larger than our columns can accommodate, and the article must be itself consulted by those who desire full information regarding this method. It is not so liable to give trouble as the first method above described.

An Unusual Combination Heating System.

THE above is what *The Metal Worker* (March 30) entitles a description of a heating plant recently installed in St. Andrew's M. E. Church in Brooklyn. It is true that, while this method of heating a church or a school is unusual, it is not new, and, when properly installed, it is so good a system that it is rather surprising that it is not more widely used. The system comprises warm-air furnace heating for mild weather and for ventilation for any weather requiring artificial heat, and a supplementary steam-heating plant, quite insufficient of itself to heat the building, but supplementing the capacity of the furnaces in cold weather. The method seems better in one respect than combination systems wherein steam-generating coils are directly combined with air-heating furnaces, and wherein, when either part of the combination is disabled, neither is available. The method under consideration makes each heating apparatus independent of the other, and hence the term "coöperative" seems to be more appropriate for it than "combination."

There is, however, one objection to this coöperative system. It requires more attention than a single plant of the same capacity. But this does not outweigh its advantages. The installment in the above-named church is a good example of the system. The entire arrangement in detail is described and illustrated in *The Metal Worker's* article. However, an inspection of the plans, as given, compels the belief that a combination of indirect and direct heating by steam would have cost no more than the coöperative system, and that the latter would consume more fuel for the same heating and ventilating effect than the former. But the question of cost is secondary in importance to that of comfort and health.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Heating and Ventilation.

30135. Notes on Steam Heating.—Why Some Plants Fail. Anon. (B J C–March 16.) 1000 w.

30274. Heating and Ventilation of the Nineteenth Ward School. Ill. (H & V–March 15.) 2700 w.

30275. Greenhouse Heating. A. H. Dudley (H & V–March 15.) 1300 w.

30282. The Care of Heating Boilers During the Summer Season. W. H. Wakeman (A M–March 21.) 800 w.

30361. Exhaust Steam Heating. Ill. William J. Baldwin (E R–March 23.) 2800 w.

30520. Practical Suggestions Respecting the Ventilation of Buildings. John H. Kellogg (A A–March 30.) 5500 w.

30524. An Unusual Combination System.—Heating and Ventilation Used at St. Andrew's M. E. Church, Brooklyn (Met W–March 30.) 1000 w.

30741. Heating and Ventilating a Milwaukee School. Ill. (E R–April 6.) 1200 w.

Landscape Gardening.

30261. Sculpture in Garden Art. Editorial (G & F–March 20.) 2000 w.

†30354. Landscape Gardening. Thomas Hawkes (I A–March.) 3400 w.

Plumbing and Gas Fitting.

*30025. Sanitary Fixtures and Fixing in Dwelling Houses (Extract.) W. Paul Gerhard (B A–March 1.) 1800 w.

*30208. An Essay on Plumbing. John Troland (Pl D–March.) 2500 w.

30272. Sewer and Drain Connections. Ill. Walter Q. James (S P–March 15.) 1200 w.

30273. The Principles of Double-Boiler Plumbing Work. Ill. Grayson (S P–March 15.) 2000 w.

30744. Lead Pipe Shower Arrangements. Ill. Grayson (S P–April 1.) 1500 w.

Serials.

29281. Steam Heating as Practiced in the United States. David Nesbit (M S F–Began Feb.—Ended March—2 parts—15 cts. each).

29334. Technical Subjects that Plumbers Should Know. F. Dye (Pl D–Began Feb.—2 parts to date—30 cts. each).

We supply copies of these articles. See introductory.

ELECTRICITY

Electric Railroads on Highways.

An important decision recently made by Judge Williams of the supreme court of Pennsylvania affecting the rights of electric railroads on public highways holds that the authorities of a township have no right to subject its highways to a servitude other than for the benefit of the township and the public it represents. The carriage of passengers through the township from one city or borough to another is held to be in no sense a township purpose, and therefore the law does not authorize the grant of a right of way along the public highway of a township for an electric or other railway. This decision seems to indicate the direction which is likely to be taken, in Pennsylvania and some other States, at least, by the contest now going on between the electric and steam railways for suburban and interurban traffic. The *Railroad Gazette* (April 5) devotes considerable space to a discussion of the questions likely to be raised by this decision, and points out that under it the street-railroad companies cannot reach the township property-owner, either through the local authorities or by the right of eminent domain; and hence it is difficult to see how such a company can protect itself in the use of country roads, except by contract with each and every property-owner along the roads which they wish to occupy, and—what adds to the difficulty—these must be dealt with individually, as their rights cannot be taken away by condemnation proceedings. It is, of course, a question how far this view of the law will hereafter be adopted in other States, but a member of the court of errors and appeals of the State of New Jersey, in an interview recently printed in the New York *Evening Post*, expresses the opinion that the decision of Judge Williams would be held applicable in that State. This decision must have the effect of seriously checking the development of interurban electric lines in Pennsylvania, of which a great number have been projected, and some have already been built. No doubt legislation will ultimately be obtained by which the right of eminent domain will be conferred upon this class of railroads, for, in so far as they are a necessary public convenience, they will be built and ought to be built; but, on the other hand, it must be admitted that the effect of the decision, in imposing some check to the current speculative craze for the unnecessary multiplication of electric roads on the public thoroughfares, is by no means a wholly undesirable one.

Electric-Railway Competition.

The recent issues of the *Railroad Gazette* contain numerous articles and paragraphs, editorial and otherwise, in reference to the latest developments in the contemporaneous warfare between the steam and electric railroads over short-distance traffic, which in some places has apparently reached what may be termed an acute phase. The new form of competition, as the *Gazette* remarks in an editorial (March 29), exhibits "one characteristic that is very familiar to every railroad officer who has been engaged in many rate-wars, and that is the fact that the aggressive competitors pay very little regard to the true cost of performing the service. Electric roads with new track and equipment can get along for awhile with very little expenditure for repairs, and it appears that in a good many cases the managers base their calculations on the false assumption that the present low percentage of operating expenses can be permanently maintained. They know it is false, but that makes no difference. Again, the favorable attitude of the public may not last, and taxes may be imposed where now everything is free; but that does not worry the man who is industriously engaged in making hay while the sun shines. On the other hand, a street-road so located as to do a large short-trip business can afford to carry passengers from village to village very cheaply, and in some cases the steam roads may have to meet three-cent fares instead of five-cent." The legislative hearing in Connecticut a few weeks since, on a measure intended to practically prohibit the granting of electric-railway franchises when in direct competition with those of existing steam lines, brought out some surprising facts as to the losses in local traffic which have been sustained by the New York, New Haven, and Hartford Railroad between certain points on its system, attributable to trolley competition. A large number of these cases represent more than 50 per cent. of the local traffic, and in not a few cases they appear to have practically taken it all. Of course, the total loss is not a large percentage of the entire gross earnings of the trains, but the trouble is that the loss is a dead loss, as the expenses are not diminished a cent, unless the train is discontinued altogether. A correspondent writing from New Haven, in the *Gazette* of April 5, points out that the electric lines have paralleled nearly the entire system of the above-named company between New York and Boston, and states that a summary of the business between points where electric competition exists shows a loss of over $4,000 for each of the winter months. What the steam railroads now ask the legislature to do is to refuse charters to electric lines which parallel the older roads, and especially to restrict the new-comers to city and suburban traffic, and prohibit their cross-country extensions. Says this correspondent: "Electric competition is soon to be a very important factor in passenger traffic on most of our railroads. It seems certain that these new lines will before long begin to do a parcels-express business, and can carry this on with great efficiency. Beyond this it is quite probable that they may eventually carry heavy freight to some extent. With this outlook, how are the steam railroads going to defend themselves? The alternative seems to be before them, either of employing electricity to a large extent on their own lines, and building cheap branches to control the traffic now in the power of these independent roads, or of buying up the electric lines outright, and operating them as an integral part of each railroad system. . . . It is the convenience of the public which must finally decide the question of competition between electric and steam railroads, and it is idle for any one to claim that electric lines shall be confined to the limit of the old horse-car roads in our larger cities."

The opinion was some time since expressed in this department that it is idle for the steam-railway companies to seek to prevent the construction of competing electric lines by restrictive legislation, for, even were this possible, the remedy comes too late. The greater part of the mischief is already done, so far as occupying the territory in dispute is concerned. It was also predicted that the ultimate solution of the problem would be that the trolley lines would come under the control and ownership of the steam lines. If we may believe the current newspapers, it is just this policy that has been decided upon by two of the principal railway companies of the country,—*viz.*, the New York, New Haven, and Hartford, and the Pennsylvania. Moreover, each of these companies has decided to equip one of its branches with electric rolling-stock, the former having selected the Nantasket Beach road near Boston, and the latter the Burlington & Mt. Holly branch in New Jersey, as the scene of its experiments. Both these lines are now being equipped, and will soon be ready for business. A similar project attributed to the New York Central Company for equipping the portion of its line lying along the Niagara river appears to be without substantial foundation, at least as an immediate probability. In spite of the figures presented, it is a question if the managers of the New York, New Haven, and Hartford company are not unnecessarily alarmed. The annual balance-sheet may show that the losses sustained by reason of trolley competition in certain localities have been more than offset by gains in other places due to the same cause. Each system of transportation will ultimately find its own field, in which it can serve the public most economically and efficiently, and this inevitable mutual adjustment is a matter which individuals, legislatures, and courts are alike powerless to prevent.

A Californian Power-Plant.

ONE of the largest available water-powers in California has been developed by damming the American river at Folsom, and the work, which has been in progress for several years, is now practically completed. The water is to be used primarily for power purposes, and afterwards for the general irrigation of a large tract of adjacent country, it being estimated that some 400,000 acres of land can be brought under cultivation by utilizing the water from the tail-races. More recently, the rapid progress which has been made in the art of electrical power-transmission has caused to be engrafted upon the original scheme a plan for utilizing the 5,000 horse-power available for the purpose to supply electrical energy to Sacramento. The electric plant, now in process of construction, is of the most advanced type, and, when completed, will be scarcely inferior in technical interest to that at Niagara. In the *Electrical Engineer* (Feb. 13) Mr. Geo. H. Guy gives some interesting general particulars of this important undertaking, with illustrations showing some of the prominent features of the hydraulic work. Four three-phase alternating generators of 1000 h. p. each are directly connected to four 1200-h. p. McCormick turbines, running at 350 revolutions per minute under 55 ft. head. Independent turbines of smaller capacity will be employed to operate the exciters. The alternators, now being built by The General Electric Company, are said to be, with the exception of those at Niagara, the largest in the world. They weigh over 40 tons each. The current is to be raised by transformers to a potential of 10,000 volts, and transmitted over a double-pole line, comprising four three-wire circuits of bare No. 0 wire, each circuit having the capacity to deliver 1000 h. p. at Sacramento,—a distance of 24 miles. The local distribution will be at a potential of 100 volts. It is probable that the completion of this plant will solve a good many interesting problems in reference to the commercial aspects of long-distance electric power-transmission.

Modern Telephonic Apparatus.

THE capacity of the modern speaking telephone for long-distance transmission is mainly due to improvements in the transmitter and in the construction of the connecting lines; the receiving instrument remains substantially the same as when first made known to the public. The *Scientific American* (Feb. 16) has a very fully illustrated article, describing in great detail the construction of the transmitting apparatus now used in this service. There is certainly a wonderful amount of invention and adaptation in this little instrument, and there could be no greater mistake than to suppose, as many do, that the owners of the telephone patents have never made particular efforts to improve their apparatus. Notwithstanding we have been repeatedly informed by the daily newspapers that there were numbers of wonderfully-improved telephones only waiting for the expiration of the Bell patents in order to be placed in the hands of the public, it is a fact that no apparatus has yet appeared which can bear a moment's comparison, in point of effectiveness, with that described in the article referred to. Every detail is the result of long-continued and minute experimentation and research, and the instrument, as a whole, performs its duties in a way that literally leaves no room for improvement.

Theory and Practice of the Transformer.

THE transformer or converter, as it is variously termed, may be regarded as the emblem of the alternating system of electrical distribution, but to the untechnical mind its nature and functions are an apparently impenetrable mystery. Mr. Caryl D. Haskins, in the *Electrical World* (Feb. 23), in an excellent article, gives a plain and straightforward explanation of the whole matter, showing what a transformer is, what it does, and how and why it does it. The subject is one of no inconsiderable scientific interest, and the masterly manner in which it has been handled by Mr. Haskins will commend his paper to all who seek information upon the subject of which it treats.

Electric Line-Construction.

IT is certainly remarkable, in view of the importance of the subject, that there has never been published a solitary treatise of any importance on the subject of electric-line-construction as practised in the United States. Possibly this may have something to do with the admitted fact that most of the line-construction in this country, viewed from an engineering or even from an electrical standpoint, is about as bad as it well can be. The lack of some sort of a standard of good practice for this line of work is apparent at every turn. An article on this subject in *Electrical Engineering* (Feb.) by Alfred Vaughn Abbott, chief engineer of the Chicago Telephone Company, occupying over fifty magazine pages, and profusely illustrated with examples for imitation and warnings for avoidance, will at least do something towards supplying the want, until supplemented by something more exhaustive. Overhead lines for electrical transmission of every kind, including those for electric railways, receive abundant consideration, and there is much of importance and value, not otherwise easily accessible, in reference to underground construction, in which very rapid advances have been made in the United States within the past ten years.

Central-Station Coal Consumption.

MR. E. A. MERRILL, in a paper in the *Electrical World* (Feb. 23), points out that the most serious problem which confronts the electric station manager is the relation between input and output,—that is to say, between the coal-pile and the switchboard. "When a station is in operation," says Mr. Merrill, "it is far more to the manager's interest to know that his 8 lbs. of coal per kilowatt and per hour cannot be bettered by any similar station than to know that his neighbor in the next town, with a different equipment and service, gets the same output on 6 lbs., and vastly more satisfactory if he knows that his neighbor ought to get the same output on 5 lbs.; a good manager is not one who gets a larger output per pound of coal than his neighbor, but one who gets the largest output possible with his station. Comparisons between stations without discrimination as to equipment or operating conditions are responsible for a great deal of unmerited praise and undeserved adverse criticism." By way of illustration, Mr. Merrill classifies a number of the most common types of central-station plants, and then gives typical sets of curves, graphically showing the relation of different conditions, such as percentage of load referred respectively to the engine and the dynamo, in lbs. of coal per h. p. hour, lbs. of coal per kilowatt-hour, and watt-hours per lb. of coal. The points which Mr. Merrill seeks to emphasize are that stations should not be compared indiscriminately; that comparisons, to be of any value, must have some common basis, and must be comprehensive and accurate; and that there is no better method of checking coal-consumption than by comparisons intelligently made.

An Electric City.

IF any one city of the United States is more than another entitled to the distinction of being called the "electric," it is a question if that city is not Los Angeles. According to an article by George H. Guy in the *Electrical Engineer* (March 13), the street-railway company distributes some 240 h. p. of electrical energy in small units throughout that city, and the catalogue which Mr. Guy gives of its various applications is no less suggestive than amusing. The principal use of the power is for elevator service and for refrigerating plants. In photo-engraving work two or three large establishments have found that electricity is an ideal power for their purposes, inasmuch as some of their necessary apparatus —for instance, the routing-machine—does its best work at a speed as high as 14,000 revolutions per minute, which is easily obtained by means of a suitable motor. Other uses to which electric power has been applied in Los Angeles are glass-cutting, stamp-cancelling in the post-offi gem-cutting, optical-grinding, coffee machinery, printing, paint-grinding, bootblacking, dough-mixing, and so on. Among other matters, a toboggan slide operated by electric motors furnishes amusement to the public. The universal use of electricity for small motors in this particular instance is due in part to the high cost of fuel, and in part apparently to the excellent quality of the service rendered.

Canal Towage by Electricity.

The Electrical Engineer (March 13) contains an illustrated description of an electrical apparatus for towing canal-boats which has been for some months in experimental use at Trenton, N. J., and which seems to embody some features of value. A wire rope "cable-way" is placed on brackets upon posts on one or both banks of the canal. An electrical motor is carried upon and operates a " hauler," which runs upon the wire-rope and propels itself by friction independently of its weight. Any existing boat, and, in fact, a string of boats, may be attached to the electric hauler, and pulled along as boats are now by mules, though at a much greater speed and less cost. It would seem as if this ingenious device avoided most of the difficulties found to exist with the trolley system, with which some partially successful attempts have been made on the Erie canal. Certainly the mode of application of the power is much more direct and efficient, and therefore in all probability more economical, than when applied to a propeller by means of a motor carried on the boat.

Untrustworthy Electric-Lighting Statistics.

Something like a year ago a table of comparative cost per year of arc-lights in cities owning and operating municipal plants, and in cities supplied by private contract, was published by W. J. Buckley, in his work on "Electric-Lighting Plants" (reviewed in this magazine, Vol. VIII, p. 576). The table was accompanied by a distinct statement that most of the reports from municipal plants included neither interest or depreciation,—two items which represent an average annual outlay of about 13 per cent. on the total cost of the plant. It is obvious, therefore, that any tables which do not include these items cannot give a trustworthy statement of the annual cost per lamp. A prominent real-estate paper of St. Paul, Minn., copied Mr. Buckley's figures as given, without stating its authority and without referring to the all-important qualification given by him. These misleading figures have been widely copied by the newspaper press of the United States, and in many instances have been accepted as authoritative and conclusive. In the *Electrical Engineer* (March 20) Mr. I. C. Wood discusses these figures, and as an illustration compares operations in Buffalo, where a private company receives 35 cts. per night for a nominal 2000-c. p. arc-light all night, with those of the municipal plant in South Norwalk, —referred to in these notes in the March number (p. 1095),—and shows that, although Buffalo pays more than twice as much per lamp as South Norwalk, it gets nearly twice as much light for its money.

Electric vs. Steam Railroads.

The Fonda, Johnstown & Gloversville (N. Y.) railroad, a prosperous branch line connecting with the New York Central, was paralleled a year or two since by an electric trolley line. It was remarked in this department at the time that an excellent opportunity would here be afforded to test in actual service the comparative merits of the two systems. Mr. T. C. Frenyear writes to the *Electrical Engineer* (March 20) that the steam road leased its electric rival shortly after its completion, and that the result has been that all the passenger business is now done by the electric road, while the old steam road is used solely for freight. Mr. Frenyear says that experience has shown the greatest advantage of the electric over the steam road to be due to its ability to operate a much greater number of train units at a given cost, the cost per motor car-mile being only about one-sixth the cost per train-mile on the steam road. The motor cars are 36 ft. long, and are provided with baggage, smoking, and ladies' compartments. They have each two

30 h. p. motors, but Mr. Frenyear thinks it would be an improvement to provide 50-h. p. motors wound for high speed, so that on a well-constructed track a speed of 40 m. p. h. might be attained, if necessary, and trail-cars handled when there is an excess of traffic. For a line having different rates of fare, the duplex cash-fare ticket has proved to be the best arrangement. Mr. Frenyear says it is perfectly feasible to operate a 12-mile road from one power house at a pressure of 500 volts, but, outside of city streets, sees no objection to a pressure of 1000 volts. Coming from a person who knows from practical experience what he is talking about, these opinions appear to be of exceptional value as a contribution to the general discussion.

Successful Water-Power Plant.

THE ELECTRICAL ENGINEER (April 3) contains an illustrated description of a device for governing water-wheels, which incidentally gives a great deal of interesting information about the power-transmission plant at Baltic, Conn., from which the Ponemah mills at Taftville and the street-railway system of the city of Norwich are supplied with power. This was one of the first three-phase plants installed in this country, and some particulars respecting it were given in this magazine last year (Vol. VII, p. 413). Until recently the excessive variations in the load have caused a great deal of trouble in the regulation of the machinery at the power-station, which, it appears, has now been in a great measure obviated. An instructive graphic diagram, showing the concurrent variations of speed and load, adds much to the interest of the article. It is stated that the use of this plant saves in cost of coal from $40 to $50 per day the year round. The distance through which the power is transmitted is 4½ miles, and the loss between generator and motor pulleys is found to average about 18 per cent., varying of course according to the load.

The *Electrical World* (March 30) publishes an abstract of a letter written by E. F. Carpenter, superintendent of the three-phase electric plant at Concord, N. H., heretofore referred to in this magazine (Vol. VII, p. 257), which has been in operation since September, 1893. He speaks very highly of the operation of this pioneer plant. There are now over 400 h. p. in motors and over 6000 incandescent lamps in operation from two 250-k. w. generators. The length of line is 4 miles, the voltage at the point of distribution being 2200 on the primary and 110 on the secondaries. The loss between the generators and transformers is 7½ per cent. under the heaviest load yet carried. The motors start promptly under load, and their variation in speed between load and no load is less than 2 per cent. Motors and lights are run from the same transformers. No difficulty is experienced in balancing the circuits; a difference in load of 25 per cent. between two sides occasions no inconvenience. A great deal of heating and cooking apparatus is in use, and the use for domestic service is rapidly increasing.

CANADIAN ELECTRICAL NEWS says that the town of St. Louis Du Mile End has entered into a contract with the Citizens' Light & Power Co., to light the streets of the town, and has also entered action against the Montreal Street Railway Company for laying their track within the limits of the municipality. The company claim that they were obliged by the city by-laws to lay down the tracks, and will hold the city of Montreal responsible for any damages which may be incurred.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Lighting.

*29961. The Illumination of Streets by Electricity. Ill. Franklin Leonard Pope (E Mag-May.) 3000 w.

30054. Elihu Thomson on the Patent Situation Resulting from the Bate Decision (E R N Y-March 13.) 1200 w.

30094. Signaling Weather Predictions by Searchlight. Ill. (W E-March 16.) 1000 w.

We supply copies of these articles. See introductory.

30112. The Candle-Power of Arc Lamps. Editorial (E N–March 14.) 2000 w.

*30204. The Cause of the St. Pancras Explosions. Editorial (E R L–March 8.) 1800 w.

*30205. The Dangers of Underground Mains (E P–March.) 1700 w.

30278. Electric Lighting Statistics. I. C. Wood (E E N Y–March 20.) 1200 w.

30328. Electric Lighting. E. A. Claremont (A & B–March 23.) 6400 w.

*30409. New Alternating Current Arc Lamp. Ill. Abstracted from Elektrotechnische Zeitschrift (E E L–March 15.) 650 w.

30433. The Logansport Municipal Lighting Plant, Combining Water and Steam Power. Ill. Carl Kammeyer (E E N Y–March 27.) 2000 w.

30461. The Blackening of Incandescent Lamps. G. Tolomei (E W–March 30.) 1100 w.

30473. Nikola Tesla and the Electric Light of the Future. Walter T. Stephenson, in The Outlook (Sc A S–March 30.) 2700 w.

30673. A Combined Electric Lighting and Water Works Plant.—St. Lazarus. Described by Max Luhn (E W–April 6.) 1400 w.

30675. Influence of Carbons on the Candle Power of the Arc Light. Wilbur M. Stine (E W–April 6.) 1200 w.

Power.

29980. Power Required for Elevators. Ill. Thomas J. Fay (E A–March 9.) 600 w.

*29996. The Practical Application of Alternating Current Motors. Ill. Walter J. Fryer (E E L–March 1.) 3500 w.

30068. The Lamb Electric Cable Way for Canal Boat Haulage. Ill. Anon. (E E N Y–March 13.) 1300 w.

30089. Power Transmission. Ossian Chytraeus (E W–March 16.) 1100 w.

30133. Niagara Falls Power. Anon. (F W–March 16.) 1600 w.

*30183. Short Air-Space Dynamos. Editorial (E–March 8.) 3900 w.

*30190. The Utilization of Niagara. Ill. Ed. C. DeSegundo (Eng L–March 8.) 4400 w.

†30194. A Method for Preventing Armature Reaction. Ill. Harris J. Ryan and Milton E. Thompson (T A I E E–March.) 5000 w.

*30203. Note on Electric Percussive Drills. Ill. Albion T. Snell (El–March 8.) 1100 w.

30267. Professor George Forbes on Niagara and Its Critics (E R N Y–March 20.) 1300 w.

30277. The Improved Ball Automatic Dynamo. Ill. Frank H. Widmayer (E E N Y–March 20.) 1200 w.

*30411. Electrical Transmission of Power in Shipyards and on Board Merchant Steamers. (Abstract.) Ill. W. Carlisle Wallace (E E L–March 15.) 2800 w.

30468. The Electric Transmission of Energy. Editorial (Sc A–March 30.) 800 w.

30752. Electrical Transmission of Power from Folsom, Cal. Ill. (W E–April 6.) 1800 w.

Telephony and Telegraphy.

30055. Telephone Service in Europe and America From Remarks of Gen. Benjamin F. Tracy (E R N Y–March 13.) 2000 w.

30064. The Theatrophone. Ill. (Sc A S–March 16.) 2300 w.

30168. Telephone Companies vs. Electric Street Railway Companies. George D. Fisher (S R G–March 16.) 1400 w.

30268. The Telephone Situation in a Nut-Shell. Editorial (E R N Y–March 20.) 1300 w.

30436. The Jacques Long Distance Vibrating Microphone. Ill. (E E N Y–March 27.) 1100 w.

30437. The Walter Combination Fire Alarm and Police Signal System. Ill. (E E N Y–March 27.) 2100 w.

30439. The Telephone Controversy in New York State.—A Summary of an Interesting Legislative Contest (E R N Y–March 27.) 1800 w.

30684. The Amstutz Electro-Artograph. Ill. (Sc A–April 6.) 1500 w.

30747. The Storage Battery in Telegraph Offices. Ill. William Finn. From the Telegraph Age (E A–April 6.) 700 w.

30823. The Interior Block System of Telephone Wiring. Ill. (E R N Y–April 10.) 500 w.

Miscellany.

29442. The Electrical Transformer. Ill. Caryl D. Haskins (E W–Feb. 23.) 3400 w.

*29964. The Modern Science of Electric Heating. W. S. Hadaway, Jr. (E Mag–May.) 3000 w.

*29987. The Propagation of Magnetism in Iron. Editorial (E–March 1.) 1800 w.

*29997. On a Proposed Modification of the Generally Accepted Temperature Co-efficient of Resistance for Copper Wires. A. E. Kennelly and Reginald A. Fessenden (E R L–March 1.) 300 w.

*29998. Atmospheric Electricity. (Abstract.) Ill. Professor Schuster (E R L–March.) 1900 w.

30056. Explosions in Underground Electric Mains and Suggestions How to Prevent Them. Arthur Shippey (E R N Y–March 13.) 1000 w.

30059. A Method of Determining the Eddy Current and Hysteresis Losses in Direct Current Armatures. A. W. K. Pierce (E N Y–March 13.) 1500 w.

30090. Electricity Direct from Fuel. C. J. Reed (E W–March 16.) 1800 w.

30142. Kelvin's Law of Economy in Conductors. Frederick A. C. Perrine (E E–March.) 1900 w.

*30172. Sodium and the St. Pancras Explosions (B–March 9.) 1200 w.

†30195. Continued Discussion of H. Ward Leonard's paper, "Notes on Recent Electrical Engineering Development in France and England" (T A I E E–March.) 8300 w.

30269. Egypt Welcomes Electricity. V. M. Berthold (E R N Y–March 20.) 600 w.

30270. To Make Safes Burglar-Proof by Electricity. G. P. Hachenberg (E R N Y–March 20.) 900 w.

30271. The Study of Atmospheric Electricity at Sea. W. F. Magie (E R N Y–March 20.) 900 w.

30291. Wires in Boston All Going Under Ground. J. C. Edgerly (W E–March 23.) 1600 w.

†30302. New Theories as to the Nature of Electricity (S In–Jan.) 3000 w.

30303. Electrical Type-Setting Machine. Ill. Invention of Father Calendoli (E W–March 23.) 500 w.

30304. Electrical Engineering at Purdue University. Ill. (E W–March 23.) 1200 w.

*30383. The Lethal Effects of Electrical Currents. H. Lewis Jones (E R L–March 15.) 2700 w.

*30385. Law Relative to Conductors of Electric Energy in France (E R L–March 15.) 700 w.

*30387. On Professor Nipher's Views on Capacity. Silvanus P. Thompson (El–March 15.) 1500 w.

30406.—75 cts. An Apparatus for Measuring Difference of Phase between Alternating Currents. Ill. Louis Derr (T Q–Oct., 1894.) 1200 w.

*30410. The Scientific Foundations of Electrical Engineering. F. G. Baily (E E L–March 15.) 2500 w.

30435. Covered Fuse Cut-Outs Dangerous. Walter E. Harrington (E E N Y–March 27.) 500 w.

30462. Microscopical Research on the Electrostatic Discharge. Ill. George T. Hanchett (E W–March 30.) 2400 w.

†30495. Tesla's Oscillator and Other Inventions.—An Authoritative Account of Some of His Recent Electrical Work. Ill. Thomas Commerford Martin (C M–April.) 8000 w.

†30548. The Velocity of Electric Waves. John Trowbridge and William Duane (A J S–April.) 3300 w.

*30640. Electric Currents of High Pressure and Periodicity. Ill. A. A. C. Swinton (E E L–March 22.) 3300 w.

30649. Nikola Tesla's Lost Apparatus. Ill. (E R N Y–April 3.) 2000 w.

30650. Tests of the Gülcher Thermo-electric Battery. Ill. (Translated.) J. S. S. (E R N Y–April 3.) 800 w.

30672. Electricity in the New York Navy Yard. Ill. (E W–April 6.) 800 w.

30797. Some Faults in the Operation of Electric Plants. C. E. Woods (E I–April.) 2200 w.

30805. Notes on the Electrostatic and Magnetic Circuit Analogy. J. E. Taylor (E R L–March 29.) 3000 w.

Serials.

22059. Practical Notes on Dynamo Calculation. Alfred E. Wiener (E W–Began May 19, 1894—33 parts to date—15 cts each).

23866. Electrodynamic Machinery. Ill. Edwin J. Houston and A. E. Kennelly (E W–Began July 21—30 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (E A–Began Aug. 25—24 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (E L–Began Oct. 5—26 parts to date—30 cts. each).

25907. The Alternating Current; Its Generation and Distribution (E I–Began Oct.—5 parts to date—15 cts. each).

26952. Electrical Power Transmission. Louis Bell (E W–Began Nov. 10—19 parts to date—15 cts. each).

27371. The Electric Light. Henry Stooke (I C B–Began Nov. 23—19 parts to date—30 cts. each).

27704. Some Hints on the Building of Electric Plants. Ill. Charles G. Armstrong (E I–Began Dec.—Ended April—5 parts—15 cts. each).

28759. The Electric Arc. Hertha Ayrton (El–Began Jan. 18—6 parts to date—30 cts. each).

29041. Recent Progress in Electrical Engineering. S. Flood Page (E Rev–Began Jan. 21—2 parts to date—30 cts. each).

29156. Technical Telegraphy Papers. James Bell and S. Wilson (E L–Began Feb. 1—9 parts to date—30 cts. each).

29158. The Construction and Use of Electrical Measuring Instruments. Charles H. Yeaman (E L–Began Feb. 1—9 parts to date—30 cts. each).

29159. Notes on Search Lights. Ill. J. Watts (E L–Began Feb. 1—5 parts to date—30 cts. each).

29798. On Slow Changes in the Magnetic Permeability of Iron. Ill. William M. Mordey (E R L–Began Feb. 22—Ended March 1—2 parts—30 cts. each).

29329. Propagation of Magnetization of Iron as Affected by the Electric Currents in the Iron. Ill. J. Hopkinson (El–Began Feb. 22—Ended March 1—2 parts—30 cts. each).

30305. Electrical Condition of Buried Conductors Due to Leakage Currents from Electric Railways. W. Stuart-Smith (E W–Began March 23—3 parts to date—15 cts. each).

30674 Gas Batteries. C. J. Reed (E W–Began April 6—1 part to date—15 cts).

30696. Electric Power Transmission. Ill. T. H. Leggett. From Tr. A. M. E. (M S P–Began March 30—1 part to date—15 cts).

30699. Operating Machine Tools by Electricity. Ill. George Richmond (I E–Began March 2—1 part to date—45 cts.)

30806. Alternate Current Motors. Ill. W. G. Rhodes (E R L–Began March 29—1 part to date—30 cts).

The Relief Department of the Pennsylvania Railroad.

THE Pennsylvania Railroad is truly a great corporation. Its greatness does not consist alone in its enormous capital, the extent of its operations, the excellence of its entire outfit, and the magnitude of its traffic. Its management, in marked contrast with that of many other railroads, is progressive, and comprehensively grasps everything—even to the welfare of its employees—that is necessary to the permanent prosperity of its interests. What a great corporation can do, and what this one is now doing, to benefit its labor element is shown in a report of its Relief Department, recently issued. *The Railroad Gazette* (March 15) editorially reviews the report, justly regarding it as a "remarkable document showing the magnitude and success of this department, which may be termed a departure from ordinary business methods." It is, however, regarded as "a departure the character of which is coming to be recognized as strictly consonant with the best business principles, although in its inception the Pennsylvania officers were largely actuated, no doubt, by philanthropic motives." Perhaps we shall be forced to admit that some corporations have souls. We abstract *The Railroad Gazette's* summary of the report. Among the discordant notes of discontent now ringing throughout the land it is encouraging and restful.

"This department was inaugurated in 1883, and provides for contributors, at a moderate cost, certain allowances or 'benefits' when they are sick or suffering from accident, and certain payments to their families or designated beneficiaries when they die. Membership is voluntary, and the number has grown from 19,952 at the close of 1886 to 33,405 on December 31, 1894. The latter number comprises more than half the employees, many of the remainder being ineligible on account of age or physical condition.

"The surplus now amounts to $273,751, but it is still insufficient for establishing a superannuation fund on a firm basis. The subject, however, is receiving the earnest attention of the advisory committee and of Superintendent Anderson. The death rate during the year was equal to 11.5 per thousand members, and the average number constantly disabled was equal to 32.3 per thousand.

"Simultaneously with the report, the company has issued a pamphlet describing the department, and stating in a plain way the results of the past 9 years. The sums shown to have been received and paid out strike the reader as something enormous. The revenue of the relief fund is stated as $4,949,011. In the distribution of this in benefits, men disabled by accident have received $722,565. To the sick has been paid $1,287,220, and the death benefits have amounted to $420,944 for accident cases and $1,279,215 for death from other causes; the total benefits amount to 3,709,945.

"The financial statement shows that there is on hand $195,935, subject to payments of liabilities, and that there is a separate surplus fund of $273,751, which has been set aside as a basis for a superannuation fund which it is intended to establish.

"No operating expenses are paid from the fund, all these being paid by the company, which also supplies office and transportation facilities. The actual cash paid by the company for operating during 9 years is stated at $636,555, in addition to $136,645 paid by the company through the Relief Department for aid to its members who remained sick after exhausting their title to benefits under the regulations governing the relief fund. The total payment for sickness has been nearly double the amount paid on account of accidents; and the amounts paid for death from ordinary causes have been over three times as great as those paid for death from accident in the service. To show the moderate cost of membership in this association, it is stated that a member may draw for sickness, in one year, as much as his dues would aggregate in 16 years, and that the death benefit is equal to the dues of 28 years; and the safety of the insurance is practically guaranteed by the Pennsylvania Railroad Company, with its $129 000,000 of capital. The Employees' Savings Fund, which is entirely distinct from the Relief Association, now has 4112 depositors. The amount received during 1894 was $366,015, and the amount of money in the fund $1,354,595." Such a policy as this toward employees shows an intelligent recognition of the main principle upon which society is based,—the mutual interdependence of all its elements, irrespective of class or station. It is an example which, we hope, will find numerous imitators.

The Real "Quintessence of Socialism."

THAT part of this title of a paper by W. H. Mallock (*The Forum* for April) which is marked by quotations is the name of a recent German treatise written by Dr. Schäffle. The two words prefixed (The Real) are Mr. Mallock's. This might mean that the latter thinks Dr. Schäffle has really perceived and described this quintessence, or that he has failed in the analysis, and that his commentator proposes to point out such failure. We see that the latter is the purpose when a little way on Mr. Mallock asserts in substance that, while what Dr. Schäffle has written is interesting, the book is more interesting on account of what its author omitted to write than on account of what he has actually written.

He (Dr. Schäffle) is, "let it be remembered, a man who, in a certain sense, speaks on the subject with an exceptional, if not unique, authority. He has devoted to the study of Socialism many years of his life. He is a complete master of its literature, or at all events the most important part of it. He has had every opportunity of observing the character and the aims of its leaders in the country where, both intellectually and practically, it has reached its highest development; and, although he has approached it as a critic rather than as a convert, he is a critic who has sought to discover its essential strength, not to discredit it by obtruding its accidental weaknesses." As to the "numerous and conflicting developments" of Socialism, it is conceded that the view expressed by Dr. Schäffle, that "whatever absurdity may be found in such developments," the "ideas and doctrines from which they spring are not absurd in themselves" is just. "They may be wrong, or right, or partly one and partly the other; but, if wrong, they are wrong in a grave and reasonable way; and they offer us a *prima facie* case for grave and careful examination. They cannot be disposed of by a laugh or a facile sarcasm."

It is further admitted that Dr. Schäffle has shown "the more extreme doctrines of the Socialists, the doctrines which appeal most easily to the imagination of the ordinary public, to have no connection with the essence of Socialism whatever." "He shows, for instance, that the position of Socialism with regard to private property is very different from the idea popularly formed of it; and that it does not of necessity tend to deprive the individual of his house, of his chattels, of an adequate private income, of freedom to spend it, of a limited freedom to save it, and even of a limited freedom to bequeath his savings to others. The whole essence of Socialism, or, as Dr. Schäffle calls it, the 'quintessence,' he shows to be comprised in the doctrine that society should, as a whole, acquire possession, not of all private property, but of a specific part only and that part is not income, but capital,—not the products, but merely the means of production. The Socialistic revolution carrried to its logical conclusion would merely turn the whole community into a single manufacturing and trading company, in which each citizen would be a wage-earner or salaried employee. No citizen would be allowed individually to own any of the means either of manufacture or exchange any more than an English officer to-day is allowed to become a shareholder in Gibraltar or in Portsmouth dock-yard.

But every citizen would be allowed to spend his salary as freely as an English officer does now, and to save it as freely. There would be this difference only: his savings would bear no interest; they would virtually be put into a stocking." But Dr. Schäffle's criticisms of this doctrine are pronounced "minute, tentative, timid, almost apologetic." However, he reaches the conclusion that, as "the efficacy of all collective labor depends on the manner in which it is directed and controlled, and as, were a whole nation converted into a single firm which manufactured and distributed everything and had to find remunerative employment for every one, the business of direction would not only be as important as it is now, but incalculably more difficult," it would be "very doubtful whether a Socialistic State would be able to find men capable of undertaking it." Mr. Mallock styles these but "so many incomplete and feeble ways of expressing the single great underlying fact which has made Socialism impossible ever since the beginning of the world, and which stands in the way of its ever being possible in the future."

This exposition of Socialism shows it to be radically different from the thing that many—perhaps most—people suppose it to be; but Mr. Mallock contends that "the proposal to substitute the State for the private employer or capitalist," so far from being the "quintessence" of Socialism, is merely the shell of a kernel, which kernel "is the proposal to reduce to an indefinite degree—indeed, practically to extinguish—the existing motive to the exercise of certain exceptional powers, which, in a Socialistic State, would be just as essential as at present, and yet to secure their exercise in all their present intensity." Of course, by "exceptional powers" is meant the ability to direct and manage a large enterprise.

"A man at present toils night and day in creating or directing some great industry, and as a reward has a palace, a picture gallery, and a yacht. Were the State suddenly Socialized, this man—or some one exactly like him—would be continued in precisely his present position and authority and asked to perform exactly the same functions. The only difference would be that his palace and his yacht would be taken from him, and his utmost hopes cut down to a six-roomed villa, which would differ very little, as Dr. Schäffle informs us, from the house of the stupidest and least efficient of the laborers whose labor, but for himself, would hardly be worth anything. This is the difference from the existing system, which is really the quintessence of Socialism; and the fundamental question on which the practicability of Socialism turns is simply this question of whether able men as a class would continue to develop and exert their faculties as they do now when nearly all the motives which cause their activity now, and which have caused it since the beginning of civilization, are carefully and deliberately, if not vindictively, annihilated."

The question here asked is not definitely answered by Mr. Mallock, but he maintains that it is "crucial," and that the entire argument criticised rests on and flows from a failure, like Dr. Schäffle's, to push the analysis of the Socialistic problem far enough, and to see that the classes of men with which Socialism professes to deal are divided, not only by the accidental fact that some men possess capital and some do not, but by the fact that some possess exceptional faculties and some do not, and that the former are just as essential to the success of Socialism as the latter. It is further asserted that the history of Socialism has shown that it does not draw into its ranks, "and does not possess in its own fold at present, men capable of directing the productive work of the world," and "that it is forbidden by its own principles to offer the only rewards that will enlist such men in its service."

The Federal Department of Labor.

In an interview with the Hon. Carroll D. Wright, by Herbert Johnston, published in *The Chautauquan* for April, an account of the organization of labor bureaus is given. There existed nothing of the kind 27 years ago,—"no regularly organized department under any government in the world, equipped and authorized to investigate systematically work, wages, and the social conditions of working people. It was purely an American idea which conceived the plan of bringing the functions of government to bear on this special field of social inquiry, and it found application first in the State of Massachusetts, when in 1869 the original bureau of statistics of labor was established."

The Massachusetts bureau of labor is credited, from the outset up to the present time, with important results. The example was soon widely followed. "To-day thirty-two American States employ this method in a variety of forms, while the federal government, through its department of labor, carries on independent investigations by the statistical method which those of the separate commonwealths admirably supplement. Nor has the American idea found acceptance in its native land alone. Seven of the foremost nations of Europe—England, France, Belgium, Germany, Russia, Austria, and Sweden—have institutions similar to our bureaus of labor statistics, their work being conducted as best suits the character and policy of their different governmental systems." Four years after the organization of this bureau, Mr. Wright was appointed its chief. Under an act approved in June, 1884, the United States bureau of labor was organized in 1885, and Mr. Wright was appointed its chief by President Arthur, who desired the bureau to be "conducted on the lines of the Massachusetts office." Mr. Wright has been retained in the office ever since, resigning a lucrative legal practice for the meager remuneration he now receives. He tells the interviewer how he has been desired by both Republican and Democratic organizations to remain in his present position. "When President Cleveland came in, I promptly tendered my resignation to Mr. Lamar, secretary of the interior, who informed me that he did not wish to accept it. In June, 1888, congress changed the bureau of labor in the department of the interior to an independent department under the title of the department of labor. This act creating the department of labor provided for a commissioner of labor, the same as the act creating the bureau which preceded it. In February, 1889, Cleveland gave me an appointment under the law, which appointment was renewed by President Harrison in 1893, and I am now serving under his commission." Mr. Wright states that the classified list of persons "annually engaged in the work of the federal department of labor" comprises "seventy-six people, of whom twenty are special agents who devote their whole time to field work. Beyond this number seventy-six, we generally employ, under special appropriation and under our miscellaneous fund, temporary experts and employees as the contingencies of the office arise. So that on the average I suppose we employ about one hundred people constantly. Sometimes we have as high as one hundred and twenty." The average annual appropriation for the work of the bureau is $175,000, exclusive of the cost of printing reports. As to the "chief practical value of such a department to the government and to the people," the commissioner says: "I have always considered the work of the department of labor as part of the educational work of the country,—that it is absurd to expect it to secure any immediate material benefit to any individual or body of individuals. The work of the department bureau of statistics of labor has, however, accomplished direct results in several directions. It has secured some very excellent legislation, and it has prevented some very vicious legislation. It helps to remove apprehensions and to correct false ideas. It puts into scientific classified form the nebulous information of the people. Through the investigations there has come into existence factory inspection and the guarding of machinery to prevent accidents, modifications of the employers' liability rule of common law, and other things which I might mention. But its chief value to my own mind is that of one of the features of the educational forces controlled by the government. Of its value to the government too much cannot be said. The department of labor is constantly employed in furnishing the press, the legislators, students, and teachers, collected information, without which they would have been obliged to deal with unknown quantities."

The Meaning and Measure of "Unemployment."

VERY much has been recently written and said about the vast numbers in commercial centers and manufacturing towns who are out of employment. Regarding it "as perhaps the most illusive term which confronts the student of modern industrial society—a term that gives rise to much unwarranted exaggeration," and adopting the view of Mr. Charles Booth, who urges that "the total number of the superfluous is the true measure of the unemployed," Mr. John A. Hobson makes an effort in *The Contemporary Review* to reach the true meaning and measure of the term "unemployed."

The idle time of those workers who from choice work 4 or 5 days per week at their trades rather than distribute their labor through the entire week cannot properly be called "unemployment" in an economic sense; but, if short time is forced upon employees in any way and in opposition to their wishes, the off-time must be so ranked. Neither can what the author styles "leakage," such as the intervals between jobs in the building trades, etc., be ranked as unemployment.

"A census of the unemployed, taken on a given day, would be apt to include a certain number of masons, bricklayers, &c., who were at leisure for this season. Yet, so far as this leakage belongs to an irregularity inherent in the trade, it cannot rank as waste, nor could the labor thus temporarily displaced be regarded as 'superfluous.' But a strict limit must be assigned to this 'necessary' leakage. If the building trade is slack, not only will a smaller number of workers be employed, but the intervals between jobs will be longer. Here there exists a genuine waste of labor-power, which would rightly rank as unemployment. A period of brisk trade in which intervals are smallest must be taken as the right measure of necessary leakage, and even then, if the leakage is due to inadequate organization in the trade, it implies some waste. In various trades improved intelligence, cheaper travelling, travelling benefits of trade unions, have reduced what would formerly have been considered necessary leakage due to natural conditions of the trade."

But seasonal fluctuations or "leakage" ought not to be assigned for the large measure of unemployment which has recently existed in nearly all lands, and the report of the British labor department, which assigns seasonal fluctuations as largely influential in causing it, is severely criticised as begging "the entire question with almost humorous effrontery." "As an alternative to the suggestion that without this unhappy margin of waiters there would not be enough men to execute the work when trade revived, I would put the following question: May not the existence under normal conditions of an average margin of 5 per cent. unemployed in the skilled trades, and possibly a larger margin in the unskilled trades, be a cause, as it is certainly a condition, of the very fluctuations which make this year good and that year bad?" If there did not exist this margin, it is evident trade could not revive to the extent it does in such a year as 1889; but, on the other hand, is it not conceivable that it might not so deeply as in 1887? In other words, is it not possible that the fluctuations would be less violent, if there did not, under normal conditions, exist an average reserve force of labor to play with?

This question is raised in "protest" against the placid assumption in the Unemployed Report that there is no "superfluity of labor, because the superfluity is sometimes for a brief period mopped up.' It is also maintained that unemployment has been greater among unionists than among union members, and that it is greater among unskilled than among skilled workmen. Some startling figures are given anent what are styled the "high-class unemployed" in England, by which is meant not the large number of professional men who fail to get sufficient business, but those who do not desire employment, living as non-producers entirely upon the produce of others' labor. These are styled "able-bodied adult paupers," and it is stated that "in England and Wales alone" on the first day of the present year there were 116,478 of this class.

The fact that in times of depression a large number of those who are thrown out of employment are found to have some individual vice or defect does not justify the charge that their unemployment is due to this cause alone. This is only one of many causes. Many who are retained in employment have the same vices and defects, and those thrown out are re-employed when trade revives again.

"Unemployment of labor, waste of labor-power, does not stand alone. At the great periods of depression we have not only unemployed labor, but unemployed capital. Nor can it be accounted a mal-adjustment of capital and labor as between trade and trade. The special characteristic of industry during a period of trade depression is that, not in this or that trade, but over the general field of industry, there is labor-power and capital lying unemployed. The actual phenomenon is a general excess of productive power. The waste of labor-power in our modern communities is evidently but one important aspect of an even larger economic problem."

New Trade-Unionism.

THE newer phases of trade-unionism in England are made the target of a very caustic criticism in the *Journal of Gas Lighting* (Feb. 12), under the caption "New Unionism Reviewed." The article is in the nature of a review of "Methods of the New Trade-Unionism" printed in the *Quarterly Review* for February, which is characterized as "more than a mere recapitulation of the outrages committed by, or in the presumed interest of, members of the new trade unions, and more than a record of the wild counsels given to infuriated mobs by men who are now members of parliament, county councillors, guardians of the poor, and so forth. It serves the purposes both of a chronicle and a criticism, inasmuch as, together with the record of what has been done in the name of trade-unionism of the new variety, it gives a survey of the writings and other influences of the times which have been more or less patently instrumental in rendering such things possible, even inevitable." Five books were named in the *Quarterly Review* as having contributed notably to current opinion on trade-unionism,—namely, "Essai sur la Répartition des Richesses," par Paul Leroy-Beaulieu (3me édition; Paris, 1888); "Le Collectivisme—Examen Critique," par Paul Leroy-Beaulieu (3me edition; Paris, 1893); "A History of Trade-Unionism," by Sidney and Beatrice Webb (London, 1894); "A Criticism of the Theory of Trades Unions," by T. S. Cree (third edition; Glasgow, 1892); "Trade-Unionism—A Criticism and a Warning," by James Birks. Of this list the *Journal of Gas Lighting* says: "This is not a long list; but it must occur to the reader that it probably represents far more systematic study than could be credited to most of the turbulent persons whose doings point the moral and adorn the tale of the reviewer. If it is necessary to read five books of what the ordinary frequenters of public free libraries in this country would designate as a 'dry' order, before one can understand anything about the true inwardness of the doings of the new trade-unionists, how many books were required to be read by the doers thereof? The answer is, obviously, none; and it puts in the most glaring light the reason for the men who know all about the why and the wherefore of popular movements not being the leaders of these manifestations, but being aloof in libraries and studies, whence their belated utterances hardly reach the crowd without. The men who figure in popular commotions do not know; the men who know do not act. And so it comes about that the largest portion of that popular passion which, if only properly directed, might move the world is spent against immovable obstacles deep-rooted in the scheme of things, but not discovered by the blind zeal of the agitator. 'Come, let us make all things new,' cries the demagogue; and he helps to create a new variety of trade-unionism to start with. For a time the organism seems charged with a lusty life, and of a strength to beat down all opposition. Nothing, or hardly anything, stands against it; only a stubborn individual here and there will not bend, only an insignificant old law or two fails to sanction the new movement. What are such obstacles to the freshet of popular frenzy? Will they not be uprooted, swept away, demolished? Nothing of the kind. They stand their ground; and in a very brief period it is seen that, while they remain, it is the popular force that has become spent. Then from his old observatory comes the calm remark of the student: 'I told you so.' It seems a pity that he could not have been heard before."

THE Leicester, England, workmen in the building trades in recent trade disputes declined arbitration. The *British Architect* says that the spring of 1895 will be memorable for poverty and distress amongst a class who ought not to suffer it.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Industrial Sociology in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

†30014. The Referendum in Switzerland. Numa Droz (C R–March.) 7800 w.

†30015. The Manchester School. Goldwin Smith (C R–March.) 5800 w.

†30016. The Meaning and Measure of "Unemployment." John A. Hobson (C R–March.) 7800 w.

†30042. On Some Legal Disabilities of Trade Unions. Bernard Holland, with Prefatory Note by the Duke of Devonshire (N C–March.) 7800 w.

†30247. Mr. Morley and the Irish Land Bill. T. W. Russell (F R–March.) 8000 w.

†30248. Politics and the Poor Law. T. Mackay (F R–March.) 6500 w.

†30249. The Crisis in Newfoundland. William Greswell (F R–March.) 3600 w.

*30260. The Labor Agitator and London Docks (Tr–March 8.) 1900 w.

*30344. Conciliation (Trade Disputes) Bill. Editorial (E–March 15.) 2000 w.

*30372. Tariff Changes and Customs Regulations.—Russia, France, Spain, Italy, United States, Colombia, San Domingo, Mexico, Guatemala, Peru, Uruguay, Canada, British India, Victoria, Queensland (B T J–March.) 6000 w.

*30375. Labor Bureaus.—A Conversation with the United States Commissioner of Labor. Recounted by Herbert Johnston (Ch–April.) 4200 w.

30440. The Relief Department of the Pennsylvania (R G–March 15.) 600 w.

*30445. What Is Economic Value? Arthur Kitson (A M C–April.) 2100 w.

*30452. The Cry of "Anarchist." Eugene V. Debs (A M C–April.) 1300 w.

*30453. Bimetallism vs. the Single Standard. L. Bradford Prince (A M C–April.) 4500 w

*30475. The Real "Quintessence of Socialism." W. H. Mallock (F–April.) 6500 w.

*30476. The Battle of Standards and the Fall of Prices. Edward Atkinson (F–April.) 6500 w.

*30477. Is Sound Finance Possible Under Popular Government? J. B. McMaster (F–April.) 5000 w.

*30479. Women in European Universities. Alice Zimmern (F–April.) 5500 w.

*30480. The Doom of the Small Town. Henry J. Fletcher (F–April.) 4200 w.

30509.—75 cts. The Quantity of Money and Prices, 1860-1891.—An Industrial Study. S. McLean Hardy (J P E–March.) 7000 w.

30510.—75 cts. The Relation of Sociology to Economics. Albion W. Small (J P E–March.) 5400 w.

30511.—75 cts. Public Ownership of Mineral Lands in the United States. George O. Virtue (J P E–March.) 6000 w.

30512.—75 cts. Credit Instruments in Retail Trade. David Kinley (J P E–March.) 3500 w.

30513.—75 cts. Belgian Monetary Legislation. H. Parker Willis (J P E–March.) 3000 w.

†30549. A Last Tribute. Thomas B. Reed (N A R–April.) 4200 w.

†30551. The Growing Greatness of the Pacific. Lorrin A. Thurston (N A R–April.) 4800 w.

†30552. The Physician and the Social Question. Paul Gibier (N A R–April.) 3500 w.

30652. The Fall of Prices The Cause and the Cure—Need of Foreign Markets. E. Benjamin Andrews (Nat Ind Review–April.) 8500 w.

†30669. Let the People Have Relief. George W. Pepperell (A–April.) 3000 w.

†30671. The American Financial System. I. E. Dean (A–April.) 5000 w.

30720. British Wheat Production Under Free Trade (S Ec–April.) 1000 w.

30721. High Wages in the United States. Emile Waxweiler (S Ec–April.) 2500 w.

30722. English Drift Toward Municipal Socialism (S Ec–April.) 3300 w.

30723. Civic Helps for Civic Life. M. M. G. Dana (S Ec–April.) 2200 w.

*30776. Wage Distribution and Average Incomes. Editorial (E–March 29.) 2000 w.

*30788. Unemployment. Editorial (Eng L–March 29.) 2000 w.

†30828. The Consuls and Foreign Trade. Editorial (I R W–April 10.) 900 w.

Serials.

28842. The Social Discontent. Henry Holt (F–Began Feb.—3 parts to date—30 cts. each).

MARINE ENGINEERING

Supersedence of Sailing Vessels.

THE extent to which steam has superseded wind for propelling ships is conspicuously shown in the business status of the Clyde shipyards, which are feeling severely the present depression in maritime traffic. In the past, when orders for steam vessels were scanty, these yards were usually able to secure enough contracts for sailing vessels to keep them at work. But *The Engineer* (London, March 1) asserts that at present very few sailing vessels are in progress, notwithstanding the fact that such orders could be very favorably placed just now; and the vessels building have mostly been ordered by speculative men, who expect to secure future purchasers. As this condition of things is in direct contrast with previous experience, an explanation of it is offered.

"It has always been understood that in times of trade depression the sailing ship had many advantages over the steamer. If only as a cheap warehouse for the storage of goods not immediately required, she was preferred to her swifter and costlier rival, the steamer; and the preference was enhanced by the fact that she afforded abundant opportunities for speculative transactions in regard to the cargo she warehoused and carried during so many weeks at a time. Then, again, she was less expensive to build, maintain, and sail than the vessel which could be moved only by the consumption of costly fuel. But these advantages and many more appear to be now outweighed by other considerations which either did not exist or were before unknown. In the first place, continued improvements in the marine engine and in steamship design have led to greater economy in steamship working; so that the relative cheapness of carrying goods by sailing ships is not so great as it was. But, over and above this, a reason for the present falling demand for sailing ships may be found in the fact that the market is already overstocked with that commodity. So simple is their construction, and so well organized and equipped with machinery and skilled labor are our mercantile shipyards, that a sailing ship of 2000 tons register is often commenced, completed, and equipped within a space of 16 weeks. In one shipyard alone, on the Clyde, it is possible to turn out thirty such vessels in the course of a year; and probably, under pressure, even that number might be exceeded. With such facilities for supplying the demands that may arise for this description of tonnage, it is not to be wondered at that the demand is not at any time of long duration. Moreover, the trades in which sailing vessels have hitherto found their chief employment are becoming fewer in number every year."

Sailing vessels now do only those "odd jobs in the trade which it does not pay steamers to meddle with." It is asserted that large sailing ships' risks are regarded with increasing distrust by marine underwriters. "Large steel sailing vessels are more frequently lost than steamers, and their losses are very often of that mysterious and painful character described by the word *missing*. . . . They sail from a port and are never after heard of." These disasters are traced to the modern increase in the size of sailing vessels. Twenty years ago a 1000-ton sailing vessel was considered large. Now 2500-ton and 3000-ton vessels are common. Large sailing vessels are admitted to possess certain commercial advantages, but these are accompanied by preponderating disadvantages. "The four-masted monsters are not so easily handled as the vessels of moderate size, and it is to be feared that this circumstance is accountable for many losses. Then, again, as coal is a common export cargo for a sailing vessel, both from the United Kingdom and New South Wales, it cannot be doubted that so enormous a volume of that treacherous mineral as can be stowed in the undivided hold of a large sailing ship conduces to the evolution of explosive gases, or the generation of heat during a long voyage, and this again is probably an explanation of many other large sailing-ship losses. Over and above these suggested causes is that of cargoes of grain and coal shifting in a gale by reason of absence of shifting boards, 'tween-deck feeders, and the other contrivances which experience might suggest to avoid such disasters. Taking one thing with another, large sailing ships have just now anything but a good name among merchants and underwriters; and, unless a sailing ship is large, she cannot, at present rate of freight, be worked at a profit, except for a few special trades limited to harbors with a small draft of water."

The opinion is expressed that, unless trade revives, the owners of large ships are not to be envied. The probable effect of this decadence upon the supply of able seamen is regretted. Sailing vessels have been the schools for training sailors, and the supply of officers for steamers has hitherto been from this source.

Proposed Lift Locks at Lockport, N. Y.

STATE ENGINEER C. W. ADAMS has proposed, as part of the Erie canal improvements, a pair of lift locks, to be constructed under an appropriation of $100,000 asked from the New York legislature, this appropriation, according to *Seaboard* (April 3), being likely to be granted. This journal copies from the *Canal Defender* an illustrated description of the proposed locks, written by Mr. Adams. The total lift being 54½ ft., or "nearly 75 per cent. greater than the largest work of the kind ever before built," Mr. Adams says: "To construct a trough of the dimensions and capacity mentioned, balanced on a central pivot according to the European method, would require about 2.4 times as much metal as in the La Louvière lift. The weight of ram, trough, etc., exclusive of water, at the La Louvière is 492 tons. Hence, for a similar lift at Lockport, we may estimate the weight of the corresponding parts at 1181 tons, making a total weight, including water, of 2331 tons for each trough. To support this weight at the same pressure per square inch on pistons as at La Louvière (469 lbs.) would require a piston about 9 1-3 ft. in diameter. To construct such a machine would obviously be enormously expensive, even if practicable at all. Again, it will be remembered that all the canal lifts heretofore built have required from 3 to 5 years for construction. Now, making all allowances for the perfection and rapidity of modern methods of working, it may still be doubted whether it would be possible to build a structure of so much greater magnitude than any heretofore attempted in the 5 winter months which alone are available for construction work at Lockport, and during which it is absolutely necessary that it be carried to completion."

The plan presented by Mr. Adams "contemplates two steel troughs or lifting chambers, side by side. The sides of the troughs will be strongly braced, both longitudinally and transversely, to resist any deformation, either from unequal loading, from unequal adjustment of the lifting apparatus, or from the shocks of boats striking the sides. Supported by this side bracing, there will be a footway along both sides of both troughs, while a transverse footway carried by each end gate will afford means of passing from one side of the trough to the other, thus providing ready access to all parts of the trough while in motion. Underneath the troughs and spaced at intervals of 5 ft. are transverse floor-beams, which carry the troughs and their contents. To the ends of the floor-beams and outside of the troughs are fastened the chains by means of which the lifting is accomplished." Power for the entire plant will be supplied by turbines. The chains will pass over sprockets, and the weight of the troughs will be balanced by counter-weights attached to the chains. Four lines of shafting will carry the sprockets.

Omitting further details of the lifting mechanism, we will quote further only what Mr. Adams says of making the junction of the troughs with the fixed portion of the canal. This "will be made by means of a metallic wedge fitting into the space to be closed, which will also be made wedge-shaped by beveling the ends of the troughs and of the approaches. The wedges will be fitted with rubber packing, will be moved by power, and will be so arranged as to be automatically adjustable to a varying clearance between the trough and approach. A single wedge will fit across the bottom and along the sides of the end of each trough, and will be driven home or released by a single motion." The lifts will be placed at the lower end of the present flight of locks Nos. 67 and 68. The troughs will be made to rise by deficiency of water, the counterweights then overbalancing the troughs, and lowered by surcharge, the weight of troughs and contents then overbalancing the counterweights. If a period of only 5 winter months be allowed to erect this plant and get it into good working order, all connected with the work will need to do some hustling.

Deflections of the Magnetic Needle.

THE NAUTICAL MAGAZINE publishes a letter upon this subject by Captain J. H. Malet, which *Scientific American Supplement* reprints. The letter has principal reference to the effects of magnetic storms (often indicated by auroras) upon eccentric variations of the compass needle. After quoting Arago (1819), Dr. Robinson (1858) and Proctor (1859) to prove that "no great aurora occurs without a magnetic storm," and as magnetic storms are considered to be correlated with solar disturbances, Capt. Malet assumes apparently that, granted perturbations in the sun's photosphere of sufficient magnitude (indicated by sun spots), the magnetic storm follows, whence the aurora, which, though an effect, is itself also a cause of eccentricities of the compass needle. Whether this line of reasoning be sound or otherwise, there is little doubt of the wisdom of the advice based upon it.

"The area of a magnetic storm may be infinite, though imperceptible to the observer. When the auroral splendor is in evidence, the navigator will do well—especially when in the vicinity of land—to watch the compasses closely for any eccentric movement which they may develop, and which, undetected, might lead his ship into danger. Indeed, as many causes combine to effect these sensitive aids,—nature of cargo, heel alteration of trim, change of latitude, and proximity of land, either in following a coast line or navigating in shoal waters,—no opportunity should be neglected by night or day to determine their errors. I fear there are too many who trust their 'deviation card' on all occasions, and find, when too late, how misplaced their confidence has been. In this connection I think it would be better for all concerned if the board of trade commissioned their representatives at the annual survey to examine the sea records of the ship's compasses in lieu of the deviation card, which is often hurriedly compiled as the ship proceeds to sea after a perfunctory attempt at adjustment, often in a tideway, and which is valueless except for local application."

Bottom Construction of Steel Vessels.

THE discrepancy between "ashore" and "afloat" strains in relation to the bottom construction of steel vessels is discussed by Joseph R. Oldman, N. A., M. E., of Cleveland, Ohio, in the *Canadian Engineer* for March. He thinks this discrepancy has been greatly misunderstood, and asserts that he has "seen ocean and lake steamers with ten or twenty consecutive floors and frames broken by light grounding, and yet the lower bottom continued keeping the ship afloat on the open sea, as if all were intact. As many are aware, when an ocean steamer constructed, say, in conformity with the 'Veritas' or 'Lloyds' Register rules is stranded under conditions which cause the bottom plating and floors to strain severely, it will usually be found that the bilge and top sides are also strained, if not fractured." It is asserted that this never occurs with lake steamers, notwithstanding their comparative lightness, one reason assigned for their exemption being that in the distribution of materials "the neutral plane is very low in the average lake steamer, as the axis is situated about two-thirds of the molded depth below the gunwale; this indicates a strong bottom and comparatively weak topsides, and the indication is correct so far as the longitudinal bending moment is concerned."

The author asks: "If a ship's bottom is proved experimentally to be amply strong for any 'afloat' stress to which it may be subject, is it necessary or advisable to increase the transverse bottom strength for the purpose of resisting rocks or uneven hard ground, which can only be resisted to a limited extent, no matter how closely the floors and frames approximate to the scantlings necessary to resist ordinary grounding strains?" The opinion is expressed that it would be better for steamers "subject to frequent groundings to leave the lower bottom about as light as it now is, but specially designed with a view to facilitate repairs, as even the lightest, well-arranged, and carefully-constructed bottoms have proved amply strong to withstand the most intense afloat stresses." But, to make surety doubly sure, he would "increase the extent, strength, efficiency, and durability of the upper bottom and bilge ceiling"; and, "as the feature desirable in bottom plating is ductility, which should not be less than 36 per cent., with a minimum tensile strength of 58,000 lbs. per sq. in.," he would "draw particular attention to these points." With reference to vessels plying in shallow waters where severe bottom damage from grounding frequently occurs, the author thinks that even "a partial remedy, or mitigation of this loss, would be of great benefit to owners of steel vessels." A 5-in. oak sheathing of steel bottoms is advocated. It is assumed that good American oak is equivalent to one-twentieth its cross-section of steel, this assumption being based on Rankine's view that oak is the equivalent of one-sixteenth its cross-section of iron. The article concludes with general remarks as to the repair of damages to ship's bottoms resulting from grounding.

Cleansing Ships' Bottoms by Electricity.

It is announced with the usual flourish of trumpets preliminary to the launching of inventions as commercial enterprises that a Kentuckian, whose name is for the present withheld, has discovered a way whereby the bottoms of sea-going vessels may be kept clean through the use of an electrical apparatus and without docking. This, if true, would be an important invention, even were the cost of the process as much as that of docking. *The Inventive Age*, which makes the announcement, says that such an invention "would be cheap at any price," but this is extravagant. The probabilities are in favor of the supposition that something of this kind will at some future time be accomplished. The industrial applications of electricity are constantly multiplying, and the announcement of almost any new use of this force now finds the public ready to receive it with credulity. It is to be hoped that the somewhat enthusiastic language of our contemporary relating to this alleged discovery or invention (for whether this yet mythical Kentuckian has discovered an invention or invented a discovery seems to us uncertain) may be fully verified by facts.

Whalebacks.

During the 5 years in which the whaleback model of vessels has been in use, thirty-nine of these vessels have been built, and the fortieth (according to an interview with Captain McDougal, reported in West Superior, Wis., *Leader*) is now on the stocks. "'The Everett is the thirty-ninth whaleback which has been built, and the fortieth vessel is now under construction at our yards at West Superior,' said Capt. McDougall. 'We started to build the Everett when things were booming on the sound, but, as the boom petered out, we finished her up for the New York and Tampico trade. If business warrants, we will keep her on the coast, and may build more vessels. Forty vessels, including 130,000 tonnage, is a pretty good record for five years. and you can judge from that whether the boats are a success. We are in competition with no class of vessels, or with all classes, as you like. All vessels are in competition for that matter, and we are in it with the rest.'"

Ship-board Lodgings for Seamen.

A law passed at the last session of congress has for its object to provide better lodgings for seamen than many owners have hitherto been willing to supply. The provisions of the law, however, do not seem to afford such a marked relief from previously-existing conditions as it might have been supposed such a law would comprise. The cubic space which it demands is almost exactly what is contained in a human grave before its occupant is laid away in it,—namely, 72 cubic ft. *Scientific American* prints the text of the new law, which was approved March 2, 1895, and will take effect April 1, 1895.

"Every place appropriated to the crew of the vessel shall have a space of not less than 72 cubic ft. and 12 superficial ft., measured on the deck or floor of that place, for each seaman or apprentice lodged therein. Such place shall be securely constructed; properly lighted, drained, and ventilated; properly protected from weather and sea; and, as far as practicable, properly shut off and protected from the effluvium of cargo or bilge water; and failure to comply with this provision shall subject the owner to a penalty of $500. Every place so occupied shall be kept free from goods or stores of any kind not being the personal property of the crew in use during the voyage; and, if any such place is not so kept free, the master shall forfeit and pay to each seaman or apprentice lodged in that place the sum of 50 cents a day for each day during which any goods or stores as aforesaid are kept or stored in the place after complaint has been made to him by any two or more of the seamen so lodged. No deduction from tonnage as aforesaid shall be made, unless there is permanently cut in a beam and over the doorway of every such place the number of men it is allowed to accommodate, with these words, 'Certified to accommodate . . . seamen.'

"That the provisions of this act apply only to vessels the construction of which shall be begun after June 30, 1895."

This movement for the betterment of sailors' quarters is commendable. The law ought to have been more liberal, but it is better than nothing.

THE TECHNICAL INDEX--1895.

Current Leading Articles on Marine Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*29963. The Great Steamers of Long Island Sound. Ill. William A. Fairburn (E Mag–May.) 3000 w.

*29995. Sailing Ships. Editorial (Eng L–March 1.) 1300 w.

*30000. Water Tube Boilers. Ill. W. H. Watkinson (I & I–March 1.) 4500 w.

30010. Bottom Construction of Steel Vessels and "Afloat" Stresses and "Ashore" Strains. Joseph R. Oldham (C Eng–March 1.) 3000 w.

*30020. The Screw Propeller. Ill. W. G. Winterburn (S L–March.) 4000 w.

30061. The Naphtha Launch of the Gas Engine and Power Company of New York City. Ill. (Sc A–March 16.) 1100 w.

*30192. Engineers and Ships of War. Editorial (Eng L–March 8.) 2000 w.

*30343. The Navy Estimates. Editorial (E–March 15.) 3500 w.

*30364. Speech of William Allan on the Naval Estimates (F'y–March 15.) 3800 w.

*30370. The Navigation and Industry of the Tyne. Editorial (I C T–March 15.) 900 w.

*30466. Protection to Agriculture and Shipping.—The Lubin Proposition Considered by Our Shipbuilders, with Editorial (Sea–March 28.) 1800 w.

30470. Ships of the New United States Navy. Ill. (Sc A–March 30.) 2300 w.

30533. The Screw Propeller. Ill. W. C. Winterburn (Eng–March 30.) 3000 w.

†30550. The Future of the Torpedo in War. P. H. Colomb (N A R–April.) 4500 w.

†30553. Screw Tug Steamer "Megna" for the Assam-Bengal State Railway. Ill. (I E–Feb. 23.) 1300 w.

30556. Electric Light-Ship at Sandy Hook. Ill. (E A–March 30.) 500 w.

*30621. The Navy in Parliament. Editorial (E–March 22.) 2200 w.

30692. The Deflection of the Magnetic Needle. J. H. Malet (Sc A S–April 6.) 1000 w.

30719. The Shortest Passage from China to New York. J. M. Cavarly (Sea–April 4.) 350 w.

*30826. The Economy of Sails in Steamships. Ill. C. Trolle (S L–April.) 3500 w.

Serials.

30482. Large Ships of Cellular Type. New System of Construction. Ill. William Bell (Am S–Began March 28—2 parts to date—15 cts. each).

30576. Turret Deck Cargo Steamers. S. O. Kendall (I & I–Began March 22—1 part to date —30 cts.)

We supply copies of these articles. See introductory.

The Scotch Boiler.

ACCORDING to Mr. Thomas Hawley, in a lecture recently delivered at Lowell before the Wells Memorial Institute, and published in *The Safety Valve* (March 15), the type of boiler usually styled the "Scotch boiler," widely used for marine purposes, is in increasing demand for use on land. This boiler has a large bottom flue in which a grate is fitted, and which thus constitutes the furnace, and an internal back connection leading to return tubes. It is an economical steamer, but is not a cheap boiler to make. This type of boiler has the advantage that large steaming power can be put in small space. If the diameter be made large and several furnaces be used, the space occupied for a given amount of steam-generating power is perhaps smaller than that required for the same steaming capacity in any other type of stationary boiler yet produced. This is one of the chief causes of the favor for marine use with which the Scotch boiler has been so long regarded.

Many large buildings have recently been erected in American cities, particularly in New York and Philadelphia, requiring for elevators and heating a considerable amount of steam. In some cases, as in the large newspaper buildings, a considerable quantity of steam is also required for running printing machinery, and space has at the same time to be economized to the utmost. A shell of as large a diameter as the Scotch boiler admits of would not be possible in an externally-fired boiler. "The ability of a circular shell to withstand rupture varies with its diameter. One-half the pressure in the boiler is sustained by the plate upon one side, and, with a given steam pressure, the greater the diameter the larger will be the strain upon the shell; and this calls for thicker plate as the diameter increases. There is a limit to the thickness of a shell through which the intense heat from the furnace must pass, and this limit determines that externally-fired boilers must not exceed a certain diameter, and 72-in. diameter is seldom exceeded. The internally-fired boiler may have as thick an external shell as desired, and large diameters are not to be avoided, since the shell can be increased in thickness to maintain any given factor of safety. This is true also of locomotive boilers outside of the internal shells of the fire-box. Twice the heating surface can be placed in the large shell of the Scotch boiler in much smaller floor-space than in an externally-fired boiler set in brick, or in the locomotive boiler. There is this disadvantage,—that there are a number of flat surfaces in these boilers, in inaccessible places, that must be carefully braced to withstand the load that will come upon them; and American manufacturers have, as a general rule, been against using a boiler that needs an elaborate system of bracing, when a boiler equally economical can be obtained without it. Such a boiler is the common return tubular. It is a simple shell with flat heads, a large number of tubes extending through the boiler from head to head. It varies in diameter up to 72-in., and in length to 22 ft. Its circular form is nature's form for strength, and needs no bracing. The heads only need to be stayed, and that by a few braces at the upper portion of the head, since the tubes brace the lower part. In the Scotch boiler there is necessary the brace of the heads, but in addition the top and water leg at the back connection, and the stiffening of the internal shell, while the locomotive boiler needs the bracing of its crown sheet, its heads, and the water legs."

The ordinary return tubular boiler occupies large space in proportion to power generated. Mr. Hawley, while commending water-tube boilers as the safest class, and speaking highly of their economy and durability in use, corrects a prevalent notion that boilers called "sectional" are always safe by virtue of that fact alone.

He says "safety in a boiler consists in having small circular units" (of space), and also in connecting these unit spaces so "that the failure of any part of the boiler will not instantly release from pressure a large body of heated water, which by its release adds to the violence of the explosion." Some of the so called safety sectional boilers "are of large cast-iron sections, totally unbraced, and are on this account open to the objection of any flat unbraced surface; and, when any of them are connected by such a large opening between the sections that the failure of one section causes a rapid release of pressure from the other sections, this may produce a violent explosion. Cast iron is a treacherous metal to use for a boiler, but, when used, it should be carefully braced, and in a manner that will insure the braces maintaining their strength in the cooling of the casting, and so that they will not be broken by shrinking strains; and the sections of the boiler should be so placed that the steam may find prompt release, yet the connections between the sections be small enough to prevent much disturbance in the remaining sections, should one break." A subclass of water-tube boilers made of iron pipes screwed together without provision for cleaning out the pipes in case of need are condemned. The necessity for the careful and skilful setting of water-tube boilers is even more pronounced than it is with the return tubular boilers.

Bursting Tests of Lap-Welded Tubes.

THE testing of both butt-welded and lap-welded pipes is a matter of common experience. In most cases the internal pressures to which pipes are subjected are so largely within that which they can withstand without bursting that the tests are instituted solely for the purpose of discovering any "pin-holes," or small leaks at the maximum pressures the pipes are intended to carry; and the test pressures are, therefore, rarely carried more than 10 or 20 lbs. above such a maximum. Occasionally, however, it has been necessary to determine the bursting pressure of pipes, in order to ascertain whether they might be applied with safety to extremely trying service. In the laying of pipe-lines for oil transportation pipes need sometimes to be subjected to the pressures of enormous heads of liquid. The specific gravity of the liquid and the head are all the data needed for computing the maximum pressure per square inch which the pipe will have to withstand; but, when this is ascertained, the question as to whether pipes of required diameter and of any particular manufacture will answer for the purpose can, in the absence of previous knowledge, be settled only by tests; and, if the pressure required approach the supposed ultimate pressure which the pipe can resist without bursting, it may be desirable to push the tests to the extent of actual rupture. The difference between the pressure at which rupture takes place and that which the pipes must successfully resist constitutes the margin in which the factor safety must be found, if, indeed, any considerable margin exists. Substantially such a case has recently occurred, and an account of it is given by M. P. S. Hildreth in *Engineering News* (March 21).

A large order for 7-in. lap-welded pipe, for use in Bolivia in a pipe-line wherein the maximum pressure was not to exceed 350 lbs. per sq. in., was divided between two well-known firms,—Morris Tasker & Company and Pancoast & Rogers. The specifications called for a test of 600 lbs. per square inch; but, in order to ascertain whether the same kind of pipe would answer for other contemplated pipe-lines in which the maximum pressure would reach 1500 lbs. per square inch, some of the pipe was tested to bursting.

"Six coupled lengths chosen at random were twice subjected to hydraulic pressure until the bursting point of a flange was reached, which occurred at 1700 and 2000 lbs. per sq. in., respectively. As in this test the longitudinal pressure was absorbed by the flange bolts only, it was decided that neither the ultimate radial strength of the pipe nor of the flanges had been reached, and therefore a new test was made under such circumstances that radial pressure only should be effective. At the second test the six lengths of pipe were tied together from end to end by two 3 in. rods, with sleeve nuts for tightening, and the whole line securely blocked and bolted down to prevent buckling. Rupture was obtained four times. At the first trial the second pipe in the line from the pump burst 6 ft. from the middle and at a pressure of 2400 lbs., leaving a longitudinal rent 18 in. long opposite the weld. Examination showed the plate to have the same thickness of metal at this point as elsewhere, but to contain a blister about 12 in. long, which undoubtedly weakened the pipe to some extent. At the second trial a flange cracked at 800 lbs., probably because the line was not screwed up evenly. At the third trial a flange burst with violence at 2300 lbs. pressure. It was replaced by a new one. At the fourth trial a flange situated at a different joint from the last burst with a violence at a pressure of 2500 lbs., one of the fragments flying 40 ft. or more. All burst flanges in this test and previous ones were female, and broke midway between the lugs into three pieces. All fractures showed sound iron of excellent quality. The pressure was gradually applied, and the line of pipe was free from serious vibration. The gaskets used for the tests were those of gutta-percha sent with the pipes, and no difficulty was found in maintaining the joints reasonably tight."

The tests were instituted and conducted by Messrs. R. W. Hildreth & Company, of New York city, who were commissioned to inspect the pipes. The weight of the pipes is stated to have been very nearly 25 lbs. per foot, and its external diameter was 7⅝ in. The thickness of the metal was therefore 5 16 in. The full description of these tests given by Mr. Hildreth is of much interest and value to mechanical engineers.

Rating Feed-Water Heaters.

THE question of rating feed-water heaters having been recently discussed by the American Society of Mechanical Engineers, and the necessity for adopting a uniform standard of rating having been admitted, the Feed-Water Heater Association, in a convention held January 26, adopted a set of resolutions relating to the rating and sale of these appliances. A circular containing these resolutions, accompanied by one stating the reasons for the action taken in the matter by the convention, has been promulgated. The resolutions to which the several members of the association have subscribed, and which they have pledged themselves to carry out both in letter and spirit, are as follows:

"That we believe that the only proper rating for feed-water heaters is based upon the square feet of heating surface contained in the heater. For the purpose of giving practical shape to this belief, we do further resolve:

"That we hereby agree that we will, in each and every case in which we are called upon to make prices upon heaters, state the exact number of square feet of surface which we are offering. To give further effect to this action, we resolve:

"That we will, in each and every case, state without reservation, both in our printed catalogues and in our specifications, the diameter of the tubes, the number of lineal feet thereof, and the total square feet of heating surface in each heater offered."

A further resolution authorizes the secretary to invite all closed-heater manufacturers to join the association and coöperate with it in adopting the system of rating named in the resolutions. In the secretary's letter the absurdity and inconvenience of a horse-power rating is set forth. "The work which a feed-water heater has to do depends upon the number of pounds of water in the shape of steam that an engine requires per hour. A single engine, of the cheapest grade, may use, say, 50 lbs. of water per horse-power per hour; an average engine will use perhaps 30 lbs. of water; while a high-grade engine will cut the consumption of water down to something like 15 lbs. per horse-power, per hour. Again, the steam which is used to heat this water will, in the case of a simple engine, have a temperature of 212°, while, in the engines of high-grade, it may have to do its work with a temperature of less than 150°."

The resolutions are signed by the following well-known feed-water heater manufacturers: The Taunton Locomotive Mfg. Co., makers of the Wainwright feed-water heater; Benj. F. Kelly & Son, makers of the Berryman feed-water heaters; Wm. Baragwanath & Son, makers of the Wm. Baragwanath feed-water heater; the Goubert Mfg. Co., makers of the Goubert feed-water heater; The National Pipe Bending Co., makers of the National feed-water heater; Robt. Wetherill & Co., makers of the Wetherill feed-water heater; and the Keystone Engine and Machine Works, makers of the Keystone feed-water heater.

Brass and Bronze in Cincinnati.

WE are in receipt of the first number of a new industrial monthly, published at Cincinnati, under the title, *Ohio Valley Industrial Review.* The pages of this monthly are 9 in. by 12 in., each containing three columns of printed matter. As indicated by the name adopted, this new-comer is devoted to the industrial interests of the Ohio valley, of which it justly regards Cincinnati as the center. We are informed by a letter from the publishers that it is their intention to revise "the best trade papers in each line, after the manner of *The Review of Reviews.*" This feature is not, however, embodied in this number. The publication is well edited, and contains a goodly number of signed articles, some of which are illustrated. We are pleased to extend a welcome to our new contemporary.

In an article entitled "Manufacture of Brass and Bronze Goods," written by Mr. Jamis Powell, the importance of Cincinnati as a manufacturing center in this line is indicated.

"The casting and founding of bells in this city constitutes the specialty of one of the most extensive establishments of this class in the country, embracing the production of all kinds, from the smallest plantation bell that invites the dusky laborer to his noon-day meal to the huge tower bell that sounds the note of alarm and arouses the 'fire laddies' to do valiant battle with the Fire Fiend; and many are they who in town, city, and country are invited to the house of worship by the chiming peals of Cincinnati bells from turret and spire.

"Cincinnati has become the noted center and source of supply to a constantly increasing and widening circle of consumers of the various articles in brass and bronze. Besides the numerous establishments of lesser degree devoted to this branch of industry, the 'Queen City' can boast of two of the very largest establishments specially engaged in this branch of business that can be found in the United States. The reputation of these establishments for excellence in the line of their manufacture is not surpassed, if equalled, anywhere; their goods are distributed throughout the length and breadth of the land, and both establishments are well represented by foreign agents, who find a ready and growing demand for their products; and it may be confidently claimed that the brass manufactures of the Queen City of the West will continue to augment and maintain a dominant factor in her industrial prosperity."

Steam Freighting with Traction Engines.

IN California not only is steam freighting with traction engines largely practised, but its use, according to the *Mining and Scientific Press,* is decidedly increasing. That paper (March 9) prefaces an illustrated description of a wagon train drawn by a traction engine with a load of 40 tons and capable of ascending a grade of 500 ft. to the mile with the remark that high-power traction engines are not only extensively, but also profitably, employed in California in this traffic. The train described "is now in use in hauling salt a distance of 30 miles over the desert in San Bernardino county in this State, from the mines of the Crystal Salt Co." to Danby, a point on the Atlantic and Pacific railroad, to be shipped to different points. This route is somewhat sandy; the train, however, makes the round trip (60 miles) in one day and a half, including loading and unloading. The cargo averages about 40 tons at each load. That is a very trying place to operate a train, owing to the loose sand to be contended with and the scarcity of water for the engine, the water being hauled in sufficient quantity from one end of the road by the engine to supply it for the round trip. However, the train is a success there, and makes it possible to market one of the great resources of this State that otherwise would lie dormant for want of a way of getting it to a shipping-point on the railroad."

"These engines are also extensively used in California for hauling logs to the mills, and lumber to the market,—some large firms owning as many as three and four each,—and at a profit considerably over that of employing animals, which were formerly used by them, the engines doing the work much more satisfactorily." A firm in Mendocino is cited as now using only two horses, whereas two years ago one hundred and fifty were used, traction engines having now supplanted animal power. It is also asserted that lumber men run their engines up grades of 800 ft. per mile in going after logs.

Who Invented the Trip Cut-Off?

FREDERICK E. SICKELS, or George Corliss,—to which should be awarded the honor of inventing the trip cut-off? This, like many other questions of prior invention, is likely to give rise to an active, if not a rancorous, controversy. The recent announcement of the demise of Mr. Sickels seems to have suggested the present as a fitting occasion for the revival of this question by an anonymous writer in *American Machinist.* This writer has gone over the whole life of Mr. Sickels, evidently with the impression that Corliss, by his superior address, won wealth and fame that should have descended upon Mr. Sickels. An editorial on the subject appears in the same paper, and also a letter from Mr. Charles T. Porter, who in steam-engineering circles is scarcely less famous than Sickels and Corliss. Both of the latter have now left the scene of controversy, and we hope the discussion thus opened will not result in dishonor to either. The editor of *American Machinist* says: "As to the strife which arose between Sickels and Corliss, we give simply the facts as we have found them. As is well-known, we have never been at all backward in according due honor to George H. Corliss either during his life-time or since its close. He was without a doubt one of the world's great engineers, and did much to advance steam-engineering practice. Wherein the account published in this issue seems to detract from his fame, all we can say is that we cannot help it. The facts are given as we have found them, and our sense of justice compels us either to publish them as found or say nothing on the subject, and we have chosen the former alternative. Men familiar with the case declare that the decision of the court in favor of Corliss hinged mainly, if not entirely, upon the assumption (supported by the testimony of experts) that the *spindle* of a cylindrical oscillating valve differed so much from the *stem* of a puppet valve that a drop cut-off arrangement applied to the former was not mechanically equivalent to such an arrangement applied to the latter form of valve. Everybody knows that this is exceedingly fine hair-splitting, and it is evident that, if the decision was founded upon this assumption only, then the board of judges on steam machinery at the Centennial was justified in awarding to Sickels the credit of the invention of the drop cut-off, which Mr. Chas. T. Porter, in his exceedingly interesting letter, says they did do. We have spared neither pains nor expense to obtain and publish either a fac-simile of this original award or a copy of it, believing there are many who, like Mr. Porter, would wish to see it made public; and Mr. Porter's letter is an ample comment upon the circumstances connected with the award. We hope yet to be able to publish the award."

The article which called out this editorial expression gives an interesting biographical sketch of Mr. Sickels, tracing his boyhood till it took him into the once famous Allaire Works in New York city. Here, as an apprentice boy, he conceived and wrought out the invention with which his name will ever be associated.

"At the age of 19 or 20 years, he devised his brilliantly simple method of obtaining the quickest closing valve possible,—an invention worthy to rank with James Watt's simple ideas of separating the condenser from the cylinder and using steam on both sides of the piston, which were the foundation, and, except details, the sum of his invention.

"With the heavy parts of such engines as Sickels, the Allaire apprentice, was familiar with in his daily life in the Allaire shops, no rapid action was possible; therefore, with that simple directness which marks inventive effort of the highest order, with that boldness and certainty of the correctness of his convictions which leads genius to its successes and the religious zealot to the stake, Sickels cut the steam admission valve away from all its massive actuating parts, so that he could have a small light piece only to move. No bolder thought in steam engineering exists than this conception of the apprentice boy of the Allaire Works. Of all the parts of the steam engine the steam admission valve must be most surely placed and handled; its time of movement must be precisely fixed with relation to piston position. To let go of this valve at one point so that the valve might be as light and hence as quickly moved as possible, and to pick it up again so as to move it with absolute certainty as to time and space, and to do this new thing with noiseless and durable mechanical elements, was the formidable task to which the boy Sickels betook himself. He succeeded amid the sneers and jeers of the recognized masters of his craft, and he reached his reward,—a life of unremitting toil, unending disappointments, poverty, actual want, the receiving of charity, and a recognition at last as one of those whose names are to live after death. It is true that Sickels saw the whole steam-using world adopt his invention of the trip" cut-off valve, the detached rapidly-closing steam admission valve, but it was as the "Corliss," not as the "Sickels," engine.

The article presents a statement that George H. Corliss was contemporaneously an apprentice with Sickels in the Allaire Works. This allegation is made on the authority of a sister of Mr. Sickels, who also says that the latter showed, explained, and talked over his invention with Corliss. The statement that Corliss and Sickels were apprentices in the works at the same time is also alleged to be corroborated by the testimony of one Richard Ryan, who was at the Allaire Works in 1844.

"Certain it is that Corliss, almost contemporaneously with Sickels, began his life-work on detaching valve-gear; certain it is, also, that, although Sickels gained some barren victories over Corliss in the courts, which were unsupported by such subsequent proceedings as might have made Sickels rich and famous, Corliss retained to the last the credit of the invention of the cut-off, millions of money."

Mr. Porter, who was one of the judges at the Centennial Exhibition who made the award to Mr. Sickels, above spoken of, says in his letter that the award "was signed by every member of the board," including Horatio Allen (another honored name in the history of steam engineering), who had formerly not been on good terms with Mr. Sickels, but who remarked concerning the award that "it was fully deserved, and that he should sign it with pleasure." Mr. Porter adds: "This award never saw the light. It was thrown out by the committee of revision, of which George H. Corliss was chairman." *American Machinist* promises in an early issue a review of the famous legal contest between Corliss and Sickels, from the pen of Mr. W. F. Durfee.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

The Machine Shop.

30281. Heel Core Prints and Their Core Boxes. Ill. John M. Richardson (A M–March 21.) 1200 w.

30284. Cutting Square Thread Screws. Ill. A Mechanic (A M–March 21.) 3000 w.

*30624. An Experimental Theory Concerning the Shearing and Punching of Metals. M. C. Fremont (C G–March 22.) 700 w.

30683. Casting a Gun by the Rodman Process. Ill. G. A. Webster (A M–April 4.) 1300 w.

We supply copies of these articles. See introductory.

Steam Engineering.

30095. Traction Engine and Train for Steam Freighting. Ill. (M S P–March 9.) 800 w.

30114. The Dryness of Steam. W. H. Booth (A M–March 14.) 1600 w.

30116. A Diagram of a Corliss Valve Motion. Ill. Sterling H. Bunnell (A M–March 14.) 1600 w.

30119. Boiler Heating Surface. Conrad Skarstedt (A M–March 14.) 1000 w.

30143. Boiler. A Note on Evaporative Tests. John C. McMynn (E E–March.) 700 w.

30144. Covering for Steam Pipes and Boilers. James Collopy (E E–March.) 500 w.

*30169. Smoke Prevention Appliances. Editorial (P Eng–March 8.) 1200 w.

*30228. Calorific Values of Different Fuels. R. C. Carpenter (S J E–March.) 3500 w.

*30229. A Graphical Method for Correcting Calorimetric Determinations. C. H. Bierbaum (S J E–March.) 1100 w.

*30233. Steam Engine Economy. Ill. T. W. Graham (Mill-Feb.) 1500 w.

30283. Notes on Piping.—Faulty Fittings. Ill. (A M–March 21.) 1300 w.

30330. Combustion of Fuel, Evaporation, Strains, Injectors, Firing, Properties of Steam. —A Short Lecture on Boilers Addressed to Practical Men (S V–March 15.) 3500 w.

30331. Tesla's Steam Engine (S V–March 15.) 1000 w.

30355. Boiler Piping.—How Done in Some Large High Pressure Plants. Ill. Discussion Before the A. S. M. E. (B J C–March 23.) 1800 w.

30356. A Violent Boiler Explosion.—A Webster Woolen Mill Wrecked (B J C–March 23.) 1000 w.

30505. The Efficiency and Capacity of Steam Fire Engines, with Editorial (E N–March 28.) 2800 w.

30571. A Comparison of Boilers. Thomas Hawley (S V–March 15.) 2700 w.

*30595. The Making of Steam. Editorial (Eng L–March 22.) 2000 w.

*30643. Steam Engine Economy. Condensing Engines. Henry Davey (I C T–March 22.) 1300 w.

*30666. The Howden System of Forced Combustion for Steam Boilers. Ill. G. W. Dickie (I S F–April.) 2500 w.

*30695. Hard Firing. Anon. (M W–March 29.) 900 w.

30740. The Rice and Sargent Engine. Ill. (E R–April 6.) 1700 w.

*30746. Steam Boilers, C. R. Tompkins (Am M–April.) 1200 w.

30799. The Future of the Steam Engine. Foree Bain (E I–April.) 1200 w.

Miscellany.

☞*29958. The Educational Influence of Machinery. A. E. Outerbridge, Jr. (E Mag.–May.) 3000 w.

*29962. A Marvel of Mechanical Achievement—Origin, Evolution and Perfection of the Bicycle. Ill. Robert Perkins (E Mag–May.) 3000 w.

30028. Planing Mill Practice. C. R. Tompkins (A S–March 9.) 1200 w.

30099. Do Patent Laws Retard Progress. Eugene L. Arnott (I Age–March.) 1500 w.

30118. Force, Energy and Power. P. Lobben (A M–March 14.) 2000 w.

30124. The Purchase of a Pump. Anon. (P A–March 15.) 3000 w.

*30200. Apprenticeship. S. E. Dibble (D E–March.) 1200 w.

30215. A New Definition of Energy—Using and Wasting of Coal. Anon. (T–March 15.) 800 w.

*30219. Remarks on Winding Engines. (Abstract.) A. M. Grant (I C T–March 8.) 2000 w.

*30231. The Manufacture of Saws. Henry H. Ritter (S J E–March.) 1600 w.

*30234. Diamond-Set Stone Saws. Anon. (S–March.) 2000 w.

30266. That Obnoxious Patent Statute—Observations on Professor Elihu Thomson's Letter. George C. Maynard (E R N Y–March 20.) 600 w.

30276. Revelations in the Combustion of Oil. Gas, and Gasoline. Ill. C. H. Land (H & V–March 15.) 1000 w.

30279. A Motor Operated by the Expansion and Contraction of Metal. Ill. (Sc A–March 23.) 350 w.

†30300. Mechanical Integrators. Ill. J. Burkitt Webb (S In–Jan.) 8500 w.

†30301. Tests of Automatic Sprinkler Heads. D. S. Jacobus (S In–Jan.) 1500 w.

30315. Tests of Lap-Welded Iron Pipe. P. S. Hildreth (E N–March 21.) 2000 w.

†30323. Garnet as an Abrasive Material. Ill. F. C. Hooper (S M Q–Jan.) 1100 w.

30333. Economy in Air Compression. Frank Richards (E M J–March 23.) 1900 w.

*30351. Overhanging Beam Pumping Engine and Crown-Valve Exhaust Gear. Ill. John G. Barclay (C G–March 15.) 500 w.

*30381. Centrifugal Fans. James Dunlop (P Eng–March 15.) 900 w.

*30397. How Shall Machinery Be Rated? The Pros and Cons Discussed in the House of Commons (M–March 15.) 3300 w.

*30398. Machinery in South Africa—Power and Plant for the Goldfields at Work and on Order (M–March 15.) 2000 w.

30434. A Handy Cable Testing Arrangement. Ill. H. Loewenherz (E E N Y–March 27.) 700 w.

30438. The Lombard Water-Wheel Governor. Ill. (E R N Y–March 27.) 1800 w.

30441. Making Tight Joints with Locknuts and Long Threads. Otto Luhr (S E–March.) 700 w.

30443. Ammonia Condensers. Otto Luhr. From Ice and Refrigeration (S E–March.) 700 w.

30456. The Proposed New Standard Screw

Thread.—Skill Required in Machine Shops. Ill. John A. McGregor (A M–March 28.) 1500 w.

30457. "Acme Standard" Screw Thread. Table Arranged by W. S. Dix (A M–March 28.) 250 w.

30458. Small Gas Engines—Firing Bituminous Coal. W. H. Booth (A M–March 28.) 2300 w.

30485. Labor as a Factor in Manufacturing. James Spiers (M S P–March 23.) 1500 w.

*30493. Danger Signals. Robert W. Lyle (B B–March.) 3600 w.

30508. Rail-Loading Machine; Lackawanna Iron and Steel Company. Invention of John A. F. Svenson (E N–March 28.) 900 w.

†30531. Saving Power. R. J. Abernathey (I Eng–Feb. 23.) 1100 w.

30538. Machine-Tool Nomenclature. Oberlin Smith (M A–April.) 1400 w,

30540. Gas Engines vs. Steam Engines. A. Bollinckx (M A–April.) 600 w.

30541. Cone Pulleys and Belts. W. L. Cheney (M A–April.) 2700 w.

30557. Changes in the Fire Brick Industry. Ill. C. F. S. (I T R–March 28.) 1500 w.

*30584. Hand and Rede Craft. Daniel C. Gilman (I C B–March 22.) 1800 w.

30660. Traveler Employed on the Park Avenue Improvement. Ill. (Ir Age–April 4.) 1000 w.

30663. H. S. Maxim on English Labor. From the N. Y. Sun (Ir Age–April 4.) 4000 w.

*30665. Early History of Wood-Working Machines. John Richards (I S F–April.) 7000 w.

30680. Riveted Joints. O. P. St. John (Pr–April.) 900 w.

30682. Frederick E. Sickels, Inventor. Ill. (A M–April 4.) 7000 w.

30686. Manufacture of Lead Pipe. Ill. (Sc A–April 6.) 600 w.

30739. Improvements in the Lonsdale Company's Power Plant. Ill. (E R–April 6.) 2400 w.

*30745. Development of Gas Engines. Charles Quast (Am M–April.) 1500 w.

*30775. The Power Absorbed by Rope and Belt Transmission. Editorial (E–March 29.) 1800 w.

*30795. Fire Extinguishing Extraordinary. —The Grinnell Sprinkler (Tr–March 29.) 2800 w.

Serials.

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (El–Began Dec. 1, 1893—32 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (E M–Began Feb., 1894—12 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E–Began March, 1894 —13 parts to date—30 cts. each).

21141. High Speed Steam Engines. Ill. John Radinger (E M–Began April, 1894—13 parts to date—30 cts. each).

24338. The Gas Engine. Ill. Anon. (P A–Began Aug. 15, 1894—11 parts to date—15 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L–Began Aug. 31—16 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Ill. Theodore F. Scheffler, Jr. (M A–Began Oct. 1894—7 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (M W–Began Dec. 7, 1894—6 parts to date—30 cts. each).

28021. Attachments and Conveniences for Universal Milling Machines. Ill. Warren E. Willis (A M–Began Dec. 27, 1894—4 parts to date—15 cts. each).

28400. The Building of a Locomotive Boiler. W. D. Wansbrough (M W–Began Jan. 4—Ended March 15—6 parts—30 cts. each).

28745. The Trials of Oil Engines at Cambridge (P Eng–Began Jan. 18—Ended March 8 —7 parts—30 cts. each).

29630. The New Nordenfelt Guns. Ill. (E–Began Feb. 15—7 parts to date—30 cts. each).

29777. The Deterioration of Locomotive and Marine Boilers Due to Expansion, and the Means of Lessening the Same. Ill. Herr Lentz (A E R J–Began March—2 parts to date—30 cts. each).

29886. Defects in Steam Boilers. Ill. From Report by the Austrian Association of Engineers and Architects (Ir Age–Began March 7—2 parts to date—15 cts. each).

30098. Inventions in the Wool Manufacture. S. N. D. North (I Age–Began March—1 part to date—15 cts).

30216. Care and Maintenance of Machinery. "Quirk" (T–Began March 15—1 part to date —15 cts).

30285. Engine Cylinders and Bed Finishing —Methods and Tools. Ill. Herman Landro (A M–Began March 21—1 part to date—15 cts).

30456. The Cornell Dividing Engine. Ill. George F. Ballou (A M–Began March 28—1 part to date—15 cts).

30555. The Proportions and Movement of Slide Valves. W. D. Wansbrough (M W–Began March 22—1 part to date—30 cts).

30617. The Making of a Bicycle. Ill. Anon. (E–Began March 22—1 part to date—30 cts).

30751. Forced Draft, and Atmospheric Condensing, for Steam Power Plants. Ill. Robert D. Kinney (E M–Began April—1 part to date—30 cts).

30810. Blast Pipes and Serve Tubes in Locomotives. Ill. (P Eng–Began March 29—1 part to date—30 cts).

30811. Experimental Theory of the Punching and Shearing of Metals. Ill. C. Fremont (P Eng–Began March 29—1 part to date—30 cts).

MINING & METALLURGY

A Triumph of Engineering Skill.

THE hard-coal Jeddo basin is about 40 miles from Wilkesbarre, and near to the highest point in Pennsylvania. The coal of this field, discovered some 10 years ago, is exceptionally good, and has commanded the highest prices. Three shafts were sunk, and prosperous villages grew up around them; the operators were making large profits, and everything was most promising. But in the spring of 1887 headings driven too near the surface caved in, and the waters of the creek suddenly flooded the workings, hundreds of the miners barely escaping with their lives. For over 2 years the district was practically deserted, hoisting-engines rusting and the great breakers falling to pieces. But the large reserves of coal were too valuable to be abandoned without an effort. Pumping out the 500,000,000 gallons of water and the steady inflow seemed impracticable. So in 1890 the operators agreed upon a plan for draining the mines by means of a 5-mile tunnel, an enterprise which was regarded by some as a probable loss of $1,500,000, in view of uncertainty as to the ground to be penetrated, there being some chance of encountering quicksand.

The *Bulletin of the American Iron and Steel Association* quotes from an exchange the details of this great work. The length of the tunnel is about 5⅛ miles, passing under two mountains and under the lowest workings (450 ft. deep) of the mines, and discharging into Butler creek. Two shafts were sunk to the tunnel-level, and progress was thus made in five headings, —two each way from each shaft and one from the tunnel mouth. Five gangs of men, fifty in each, were employed. Progress was slow, owing to hardness of the rock, necessitating constant blasting. Power-drills operated by compressed air were employed, and altogether 350,000 lbs. of forcite were used in blasting. The dimensions of the tunnel as originally planned were 8 by 8 ft., but the contractors, finding this an inconvenient cross-section, changed to 7 by 9 ft. and made faster headway. Water was encountered in quantity, and seven pumps were kept busy clearing the unconnected drifts. The surveys appear to have been very accurate. The first connection, between headings Nos. 3 and 4, was made in September, 1894, and the alignment found to be perfect, there being not more than an inch difference in the floors of the two sections. Soon afterward the connection between Nos. 1 and 2 and the outlet was made. Meanwhile, as the tunnel was nearing completion, a bore hole was put down from the surface, passing through one of the flooded gangways, and piercing the center of the roof of the drainage tunnel. This bore was so accurate that it came out within a 6-in. circle marked in the tunnel roof. It was so well cased that only "about a gallon a day" leaked into the tunnel. To withdraw the 6″ × 4″ hickory plug and the casing was the work of but half an hour, and the mines were successfully tapped. Some delay was caused by an injunction granted to a farmer in Butler Valley, who feared damage to his land by flooding; but this was adjusted, it being shown that the water would pass out at a rate of only about 8000 gallons per minute. The right of way past other lands had previously been secured by the operators. A gratifying feature of this great undertaking is that not a man was killed, despite the amount of blasting done, and only four men injured in any way. The tunnel is expected to bring prosperity back to a long desolate region.

The Genesis of Ore Deposits.

ONE of the most notable recent contributions to the science of economic geology, viewed from the theoretical standpoint, is the criticism by Prof. Joseph Le Conte (offered at the Bridgeport meeting of the American Institute of Mining Engineers) on Bergrath F. Posepny's great essay on the genesis of ore deposits. This latter has elicited much interesting and some useful discussion. After doing jnstice to the high merits of Posepny's treatise, Prof. Le Conte "cannot but think that he [Posepny] carries his ascension views much too far; that, in his zeal against the extreme lateral-secretion views of Sandberger, he has gone to the other extreme of ascensionism; and that a truer view than either may be found in one that shall combine and reconcile these two extremes." It will be remembered that Posepny draws a sharp distinction between the superficial and the deep circulation of underground waters: the water in the former case containing air, and therefore oxidizing; the water in the other case being destitute of air, and therefore non-oxidizing; the one circulation being driven by gravity alone, the direction of current being determined by the plane of outflow; the other being driven largely by heat received in the lower parts of its circuit, and the direction of its current being mainly upward,—from which view it follows that metallic sulphids are not deposited from the waters of the "vadose" (superficial) circulation, unless under the exceptional conditions of the presence of excess of organic matter; and therefore that the presence of metals in the form of sulphids is usually a sign of deposit from ascending waters of the deeper non-oxidizing circulation. Posepny has also introduced, as a substitute for the indefinite "unknown depths" of other geologists, the term "barysphere" to define a region in the interior of the earth, the materials of which are heavier, because more metalliferous, than the superficial "lithosphere" visible to us. This "barysphere" would therefore be the source of ore deposits, and not the higher rocks; but Sandberger and his followers have demonstrated by refined analyses that these upper rocks, especially in their heavier basic mineral constituents, contain the metals in sufficient quantity to form ore deposits by leaching, concentration, and precipitation.

Prof. Le Conte, inquiring whether there is a "barysphere" within reach of circulating water, admits (as all do) that there must be such a region somewhere, but doubts whether it is near enough to the surface. The mean density of the earth as a whole being about 5.5, while that of the surface rocks is about 2.5, he argues that, assuming the simplest rate of increase,—a uniform one,—the central density would be 14.5, and an actual density equal to the mean density would be found at a depth of 1000 miles. At a depth of 100 miles, therefore, the increase would be 0.3 and the density only 2.8; but that is only about the density of the more basic eruptives. But Prof. Le Conte does not believe it probable that circulating water ever comes up from any such depth. It may come, he thinks, from as deep as ten miles, where the increase over the superficial density would be wholly inappreciable. If the rate of increase is not uniform, on either explanation of the high mean density of the earth, whether (1) by condensation by increasing pressure or (2) arrangement of materials of a primal fused earth according to their relative specific gravities,—the probability being in favor of both causes,—at all events the increase must be progressive toward the center, and he thinks it hard to conceive the conditions under which a dense metalliferous shell a little way beneath the surface could be formed. From a chain of reasoning which cannot be followed here he concludes that below a certain moderate depth—say 8 or 10 miles—there is no true circulation. Below this the compactness of the rocks from increasing pressure would inhibit further penetration; while capillarity, which strongly impels movement in dry porous materials, also acts as strongly to retard it, once the rocks become saturated.

Prof. Le Conte believes that a more comprehensive theory than the ascension or the lateral-secretion theories is needed, and that, in the uncolored light of a broader view, many of the difficulties and obscurities of the subject disappear. His general conclusions are:

"1. Ore deposits, using the term in its widest sense, may take place from many kinds of waters, but especially from alkaline solutions; for these are the natural solvents of metallic sulphids, and metallic sulphids are usually the original form of such deposits.

"2. They may take place from waters at any temperature and pressure, but mainly from those at high temperature and under heavy pressure, because, on account of their great solvent power, such waters are heavily freighted with metals.

"3. The depositing waters may be moving in any direction,—up-coming, horizontally moving, or even sometimes downgoing, but mainly up-coming, because by losing heat and pressure at every step such waters are sure to deposit abundantly." [This has been used by some as an argument that mines, as a general rule, increase in richness with depth,—a state of things not substantiated by experience.]

"4. Deposits may take place in any kind of waterways—in open fissures, in incipient fissures, joints, cracks, and even in porous sandstone, but especially in great open fissures, because these are the main highways of ascending waters from the greatest depths.

"5. Deposits may be found in many regions and in many kinds of rocks, but mainly in mountain regions and in metamorphic and igneous rocks, because the thermosphere is nearer the surface, and ready access thereto through great fissures is found mostly in these regions and in these rocks."

North Carolina Monazite.

INQUIRIES having been made of this department as to the character and uses of this peculiar mineral, monazite, the following facts, taken from a paper read by Mr. H. B. C. Nitze before the American Institute of Mining Engineers, will be of interest as giving information additional to what has already been published. Monazite is a phosphate of the rare earths,—cerium, lanthanium, and didymium. It also contains thoria and silica in varying percentages, probably as impurities. Its economic value lies principally in the thoria which it contains; this is used as one of the constituents of the mantles for the Welsbach and other incandescent gaslights. Although somewhat widely distributed, monazite, until now, has been found in commercial quantities only in Brazil, Siberia, Norway, and North and South Carolina. The whole North Carolina area contains between 1600 and 2000 square miles, but the mineral is only found in scattered localities along creeks, mainly in four counties, with some less important outlying occurrences. It occurs in the sands and gravels of the stream beds, associated with other minerals, such as quartz, feldspar, hornblende, epidote, magnetite, etc., and is separated from most of these, owing to its superior specific gravity (4.9 to 5.3), by washing in sluice boxes in much the same way as placer gold is won, the heavy magnetite, however, being removed by treating the dry sand, after washing, with a magnet.

The primary sources of monazite are the crystalline gneisses and schists, of which it is an accessory constituent. By the decomposition and disintegration of these rocks and a natural process of partial sorting and concentration the stream deposits are formed. The percentage of thoria is variable, and the value of the mineral consequently varies accordingly, and must be determined by analysis. It is stated that the transparent greenish and yellowish-brown varieties are usually the richest. Some high-grade specimens have from 4 to 6.60 per cent. of thoria; other good samples run from 2.76 to 3.30 per cent.; but the fluctuations are considerable, even in the same locality. The commercially-prepared mineral, after being washed over several times and treated with a magnet, is not pure monazite, as the concentrate may contain several of the other heavier non-magnetic minerals. A cleaned sand containing 60 per cent. of monazite is considered good.

The stream deposits are from 1 to 2 ft. thick, the width seldom being over 12 ft. The sluice boxes are about 8′ × 20″ × 20″. Two men work at a box, one digging the gravel and shoveling it into the box, the other working it up and down with a gravel fork or perforated shovel. The boxes are cleaned up after the day's work. From 30 to 35 lbs. of cleaned monazite sand per hand is a good average. The value of the best grades is 6 to 7 cents per pound at the diggings. In the last 2 years the North Carolina shipments were reported as 546,855 pounds, worth $36,192. This is considerably less than some of the highly-colored accounts would indicate.

A Great Copper Mine.

TAMARACK mine, Keweenaw peninsula, Lake Superior, Michigan, is described by Mr. Charles S. Herzig in the *Colliery Engineer* for March. The district is the second largest copper producer in the world, Montana now leading, and in it the Tamarack is second in importance only to the famous Calumet & Hecla, which has paid $41,000,000 in dividends. The bed the Tamarack is working on is known as the Calumet & Hecla conglomerate, and outcrops for 4200 ft. in the property of the mine from which it was named. The latter mine had followed it down by a series of inclines about 600 ft. apart, the bed dipping toward the Tamarack ground on the west, at an angle of 38°. Under the advice and management of Capt. Daniell, of the Tamarack company, a full-sized vertical shaft, 8 by 20 ft., was sunk to tap the bed at a depth of over 2000 ft. After an outlay of $700,000 and at the end of 2 years, this very plucky enterprise, as Mr. Herzig well terms it, was rewarded by a striking of the lode at 2200 ft., and within a very few feet of the calculated distance. This was in 1882. Later shaft No. 2 was started, and it struck the lode at 2000 ft. in 1884.

The deposit is a peculiar one, its regularity never having been equalled in any other metal mine. As far as explored, the dip is almost uniform—38°. Its thickness is from 8 to 21 ft., averaging about 12 ft. Copper is disseminated through it in metallic particles, from microscopic size up to large masses. The conglomerate is very coarse, containing large pebbles cemented together by silicious matter and frequently by the copper itself. In opposition to the general rule, the deposit has held out in depth without change,—not with the usual alteration products of oxidation at the surface running into sulphids in depth, but containing native copper at all depths.

The new shafts, Nos. 3 and 4, are the two deepest shafts in the world. No. 3 struck the lode in August, 1894, at a depth of 4185 ft. vertical, and No. 4 will have reached it at about 225 ft. deeper before this notice is printed. These shafts were sunk at the rate of about 80 ft. per month, No. 4 having been sunk 977 ft. last year.

The surface plant is extensive, there being two hoisting engines for each shaft. No. 2 shaft, described by Mr. Herzig as typical, has three compartments, two for the main cages and one for the tool cage. Surface water is taken care of by small pumps. No heavy pumping engines are needed, the mine being so dry that a tank-car making ten or twelve trips daily easily handles the water.

From each shaft a series of cross cuts, 60 and 80 ft. apart vertically, are run to the lode, and levels opened each way along it. All the material, from wall to wall, is stoped out, and very heavy timbering is required, there being very little waste for filling. The percentage of copper in the conglomerate varies between 1 and 3½ per cent. of all the rock mined. The ore is crushed by drop hammers, screened over grizzlies, and crushed again by five large Blake crushers to about the size of a fist; the masses of pure copper and the rich *epidote* boulders are picked out by rough hand-sorting as a special grade; and the rest is sent to the mills, where it is further reduced by steam stamps, and concentrated. The concentrates are then smelted into ingot copper.

Recent Development of the Coke Industry.

A VERY concise review of the world's coke industry—a great one in all iron-making countries except, perhaps, Sweden—is given in the *Colliery Guardian*. Remarkable progress has been made within recent years in two directions: first, in the increase in the number of coke-making plants; and, second, in the transition (on the continent of Europe at least) from the old-fashioned forms, and especially the beehive, to the newer types, originated and adopted chiefly in German and Belgium, which enable the tar and ammonia by-products to be saved.

In the United States, in the 14 years beginning with 1880, the Connellsville region (Pennsylvania) has doubled the quantity of the yearly coke output, or 5,454,000 tons in 1894 against 2,206,000 tons in 1880, the number of ovens increasing from 7,211 to 17,834 in the same period. As the development of this region has been comparatively recent and so rapid, it would be reasonable, remarks the *Colliery Guardian*, to look for a general adoption there of the newest types of oven and the most advanced modes of manufacture. Such, however, has not been the case. The coke industry of the United States has followed the practice of Great Britain in adhering to the beehive system, in which no attempt is made to recover the by-products, and where an enormous waste of valuable residue is allowed to go on. Our contemporary suggests that this may be mainly due to the fact that coke can be manufactured in the Connellsville and other leading districts so cheaply that there has hitherto been little inducement to make it any cheaper. In the last two years the Connellsville price has touched 90 cents a ton, the average for 1894 being about $1.04. This cheapness of coke has greatly lowered the cost of making pig iron, but there can be little margin for profit to the coke manufacturers. Experiments made in Germany with American coal burned in patent ovens have given satisfactory results,—71 to 72 per cent. of good furnace coal, with a residue of 1 to 2 per cent. of small coke and ash.

In Germany two systems of ovens have made rapid progress,—the Otto-Coppée and the Otto-Hoffmann; 6399 of the former and 1759 of the latter had been built up to the close of 1894. Besides these the Germans use a few ovens constructed on the Sennet-Solvay system, which, however, is more in favor in Belgium. In France a fourth type, the Carvès-Seibel, is used, and a fifth type, the Simon-Carvès, has been built to the number of 400. Two or three other systems have been tried on a smaller scale in Europe. In England but little progress has been made in the introduction of the patent ovens, though experimental plants have not been lacking. There seems to be a prejudice against "patent" coke among furnace-men, because it lacks the lightness and luster of the beehive coke. The *Colliery Guardian* says as to this: "It is greatly against England that the pig-iron manufacturers have to pay more for their coke than their competitors in the United States or Germany: but, if their own prejudices have hitherto stood in the way of enabling coke-makers to supply them with cheaper material, they can hardly blame others for what appears to be their own perversity. The Germans have certainly proved that patent-oven coke can be made more cheaply than beehive coke, and they claim to have demonstrated that its quality is not in any way inferior."

Speculation in Mines.

SPEAKING of the revival of speculative interest in mining stocks during the past year or so, and especially in England, the London *Mining Journal* marks the distinction between the two classes of buyers and their different motives. "In the former case we have what may be termed commercial mining, undertaken in the same manner as any other branch of business, and we believe with as good an average prospect of success; and, in the other, speculative mining, in which profit is looked for, not so much from the mine itself, but from operations on the market, which may too often be described as sheer gambling." Perhaps the *Mining Journal* might do well to include a third class,—those who buy to hold for dividends, but who do so without any intelligent understanding of the business, and whose investment is, therefore, a mere trusting to second-hand information, to the credibility of promoters, or to mere luck. This is quite as much "sheer gambling" as buying shares for a rise. But the *Journal's* estimate of the average prospects of legitimate mining, "undertaken in the same manner as any other branch of business,"—that is, with full knowledge of the conditions and some insight into the character of the mining business,—is entirely justifiable.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Metallurgy.

*29989. Chinese Development and the British Iron Trade (C G–March 1.) 1600 w.

*30005. Concentration and Cyanide. Editorial (M J–March 2.) 800 w.

30007. Impurities of Commercial Industrial Aluminum. Henri Moissan in Comptes Rendus (A M & I W–March 8.) 600 w.

*30013. Producer Gas as Applied to Foundry Purposes. George T. Prince (I C T–March 1.) 3800 w.

*30032. Furnaces for Roasting Gold-Bearing Ores. Ill. C. G. Warnford Lock, with Discussion (J S A–March 1.) 6400 w.

†30069. Nickel and Nickel Steel. Francis L. Sperry (Tr A M E–March.) 4300 w.

†30073. The Nomenclature of Zinc-Ores. Walter Reuben Ingalls (Tr A M E–March.) 800 w.

†30076. Aluminum-Bronze. Leonard Waldo (Tr A M E–March.) 1700 w.

†30077. A Water-Cooling Apparatus. Carl Henrich (Tr A M E–March.) 2000 w.

†30079. Close Sizing before Jigging. Robert H. Richards. (Discussion.) (Tr A M E–March.) 4500 w.

†30081. Magnesia and Sulphur in Blast Furnace Cinders. Continued Discussion of paper by Mr. Firmstone (Tr A M E–March.) 1500 w.

30087. The Permeability of Mild Steel. Dugald C. Jackson (E W–March 16.) 400 w.

30103. The Crystallization of Steel. Editorial (R G–March 15.) 2200 w.

30117. Pressure on Broach. D. C. Woodward (A M–March 14.) 1000 w.

30121. The Philosophy of Stamp-Milling. T. A. Rickard (E M J–March 16.) 3000 w.

30122. Preparation and Properties of Titanium. Henri Moissan (E M J–March 16.) 800 w.

30141. Sulphuric Acid Making from Gold Ores at Blacksburg, S. C. (M R–March 15.) 700 w.

*30186. The Present Development of the Coke Industry. Anon. (C G–March 8.) 1300 w.

*30218. The Armor-Plate Problem of To-Day. Anon. (I C T–March 8.) 2200 w.

*30258. Electrical Precipitation of Gold.—Criticism on A. Von Gernet's Article (A M S–Feb. 16.) 2000 w.

†30262. The Superiority of Barium Hydroxide Solution As an Absorbent in Carbon Determinations in Steel. James O. Handy (J A C S–April.) 1200 w.

†30264. Note on the Estimation of Iron and Alumina in Phosphates. K. P. McElroy (J A C. S–April.) 900 w.

30286. Gas from Coke Ovens. Dr. Schniewind (Ir Age–March 2[illegible].) 4300 w.

30288. The Carnegie Armor Plate Test. Ill. (Ir Age–March 21.) 900 w.

30320. A Water-Cooling Apparatus. Ill. (E N–March 21.) 2000 w.

†30322. Theory of Electro-metallurgy. Francis B. Crocker (S M Q–Jan.) 11000 w.

30332. Sub-classification of Zenogenous Ore Deposits. John B. Hastings (E M J–March 23.) 2200 w.

30335. Furnace Dust-Catcher Refuse. William B. Phillips (I T R–March 21.) 600 w.

*30357. Electrolysis of Gold.—Patent of N. S. Keith (Min W–March 16.) 1000 w.

*30384. Blast Furnace Motor Gas. W. H. Booth (E R L–March 15.) 1800 w.

30408.—75 cts. Close Sizing before Jigging, Ill. Robert H. Richards (T Q–Oct. 1894.) 9000 w.

30459. Modern Furnace vs. Cupola Practice. Thomas D. West (A M–March 28.) 3000 w.

30460. The Proposed Restriction of Welsh Tin Plate Production (Ir Age–March 28.) 900 w.

30534. Boiler Steel Requirements. Boiler Maker (Eng–March 30.) 1000 w.

30544. The Semet-Solvay vs. the Otto-Hoffman Ovens. John H. Darby, with Editorial (A M & I W–March 29.) 2500 w.

30558. Jugglery in Testing Cast Iron. Thomas D. West (I T R–March 28.) 2500 w.

*30590. Iron and Brass. J. W. Singer, with Discussion (B–March 28.) 7800 w.

*30608. Dr. Keith's Paper at the I. E. E.—An Abortive Discussion. Desmond G. Fitzgerald (E R L–March 22.) 1700 w.

*30623. The Iron Industry of France.—From the Statistique de l'Industrie Minérale (C G–March 22.) 2800 w.

*30626. The Flue-Dust Condensers of the Freiberg Smelting-Works. C. H. Bauer (C G–March 22.) 1400 w.

*30628. The Desulphurization of Liquid Cast Iron. Ch. Walrand (C G–March 22.) 1500 w.

30661. Standard Tests of Iron and Steel.—Report of Com. of Amer. Soc. of Civ. Eng. (Ir Age–April 4.) 1400 w.

30664. Notes on Northern and Southern Foundry Irons. C. A. Meissner (Ir Age–April 4.) 1200 w.

30689. The Cyanide Process on the Witwatersrand (Transvaal) Gold Fields. M. Eissler (Sc A S–April 6.) 1500 w.

*30703. Nickel Steel: Its Special Value for Armor. W. H. Jaques (E Rev–Feb. 20.) 1500 w.

*30704. A Modern South African Banket Gold Extracting Plant. B. H. Thwaite (E Rev–Feb. 20.) 1300 w.

30738. Design and Construction of Tall Steel Stacks. Ill. (E R–April 6.) 1100 w.

30756. The Desulphurization of Liquid Pig Iron. A. Volthaire (E M J–April 6.) 1100 w.

*30782. The Comparative Metallic and Money Values of Iron Ores. Walter J. May (C G–March 29.) 900 w.

30807. Study of the Physics of Cast Iron. William R. Webster (I T R–April 4.) 500 w.

Mining.

*29959. Mine Reports and Mine Salting. William McDermott (E Mag–May.) 3000 w.

*29991. Coal Mining in South Africa—Brakpan Colliery. From the South African Mining Journal (C G–March 1.) 3000 w.

*30004. Speculation in Mines. Editorial (M J–March 2.) 900 w.

30022. Slate—Its History and General Utility. George H. Harris (M I T–March 7.) 1400 w.

*30033. Coal Mining Under Sidney Harbor (Tr–March 1.) 1800 w.

30045. A Wonderful Triumph of Engineering Skill.—Jeddo Basin Tunnel (B I S–March 10.) 1800 w.

*30046. A Great Copper Mine—The Tamarack Mine, Lake Superior Peninsula, Mich. Ill. Charles S. Herzig (C E–March.) 2200 w.

†30071. Cinnabar in Texas. William P. Blake (Tr A M E–March.) 2500 w.

†30072. North Carolina Monazite. H. B. C. Nitze (Tr A M E–March.) 800 w.

†30074. The Nickel Mine at Lancaster Gap, Pa., and the Pyrrhotite Deposit at Anthony's Nose on the Hudson. I. F. Kemp. (Discussion) 1500 w.

†30075. The Tin Deposits of Durango, Mexico. Ill. Walter Renton Ingalls (Tr A M E–March.) 5000 w.

†30078. The White Phosphates of Tennessee. Charles Willard Hayes (Tr A M E–March.) 2500 w.

†30080. The Genesis of Ore Deposits.—Continued Discussion of Paper by Bergrath F. Posepny. Joseph Le Conte (Tr A M E–March.) 3500 w.

†30082. Coal Dust as an Explosive Agent.—Continued Discussion of paper by Mr. Glenn (Tr A M E–March.) 3000 w.

†30083. The Dikes and Reefs of Bendigo.—Continued Discussion of paper of T. A. Rickard (Tr A M E–March.) 3000 w.

30138. Mineral and Timber Wealth in West Virginia. A. B. Fleming (M R–March 15.) 2500 w.

30139. The Coal Fields of West Virginia. Jed. Hotchkiss (M R–March 15.) 7500 w.

*30185. Coal in New Caledonia. (Extract.) M. Jeantet (C G–March 8.) 2000 w.

*30187. How Coal Comes to London. C. H. Grinling (C G–March 8.) 800 w.

30217. Copper Mining in the South.—Ducktown, Tenn. (T–March 15.) 2800 w.

*30220. Dundas Coal Fields. Brenton Symons (M J–March 9.) 1000 w.

*30223. Gold in Colorado. A Correspondent (M J–March 9.) 1800 w.

*30225. The Mineral Wealth of Russia and Siberia. Editorial (M J–March 9.) 1500 w.

*30226. The Covadonga Manganese District and Its Mines. J. A. Jones (M J–March 9.) 1700 w.

*30227. Mining in Sonora, Mexico. J. Howard Palmer (M J–March 9.) 2000 w.

30240. Distribution of Phosphorus and System of Sampling at the Pewabic Mine. E. F. Brown, with Discussion (I T R–March 14.) 2200 w.

30241. Open Pit Mining on the Mesabi Range. F. W. Denton (I T R–March 14.) 3400 w.

30246. Natural Gas in California (A M & I W–March 15.) 1000 w.

*30251. Petroleum and Natural Gas. (Abstract.) H. M. Cadell (A M S–Jan. 26.) 2000 w.

*30252. Recent Work at Mount Lyell (Tas.) (A M S–Jan 26.) 1500 w.

*30254. The First Auriferous Drift—In Search of It in the Ballarat Goldfield. Nicholas Reed (A M S–Feb. 2.) 1200 w.

30310 Drainage in Mines. William Nance (M S P–March 16.) 1200 w.

†30325. A Plumbing Method for Steep Shafts. Ill. R. G. Brown (S MQ–Jan.) 700 w.

30334. Ducktown, Tenn., Copper Mining District. Ill. William M. Brewer (E M J–March 23.) 1200 w.

*30346. The Malafolie Colliery, Saint Etienne, Loire, France (C G–March 15.) 1800 w.

*30348. The Use of Explosives in Belgian Collieries. From Report of Victor Watteque (C G–March 15.) 2400 w.

*30393. Slate and Slate Mining. C. Le Neve Foster (M J–March 16.) 800 w.

*30396. Rand Mines as an Investment. Editorial (M J–March 16.) 700 w.

30483. The Greatest Gold Field. Dan De Quille (M S P–March 23.) 2000 w.

30494. A Free School of Mines. Courtenay De Kalb (M R–March 29.) 1000 w.

*30642. Underground Haulage Roads and How to Maintain Them (Abstract). Mr. Halliwell (I C T–March 22.) 2800 w.

*30647. Summaries of Mineral Statistics for 1894. Editorial (M J–March 23.) 2200 w.

*30648. Syndicates. Editorial (M J–March 23.) 1200 w.

30657. Gold Mining in Georgia. Anon. (T–April 1.) 2400 w.

30659. Electricity for Mining Plants. The Various Uses to Which It Is Applied.—The Cost. Anon. (T–April 1.) 2300 w.

30685. An Ohio Natural Gas Well. Ill (ScA–April 6.) 600 w.

†30694. Corundum (I E–March 2.) 800 w.

*30724. Prospectors' Tools.—Description of Tools Used and How to Sharpen and Temper Them. Ill. Arthur Lakes (C E–April.) 2800 w.

*30727. Compressed Air in Mining Operations. Charles C. Hanson (C E–April.) 1300 w.

*30729. Geologic Conditions of Economic Mining in Iowa. H. Foster Bain (C E–April.) 2800 w.

*30781. The Mineral Fuels of Chili and Their Preparation. Henri Babinski (C G–March 29.) 4800 w.

*30783. Working Coal Mines Out of Bounds (C G–March 29.) 4000 w.

*30784. The Mines of Bosnia and Herzegovina. From Report by Consul General Freeman (C G–March 29.) 1700 w.

*30785. The Haematite Ores of the West Coast (C G–March 29.) 1100 w.

*30786. Metal Mining (Extract). J. H. Collins (C G–March 29.) 4000 w.

30808. Steel Structures at Mines. Harry J. Lewis (I T R–April 4.) 1800 w.

Miscellany.

*30347. The Wages Cost of Producing Coal. Anon. (C G–March 15.) 900 w.

*30349. Contracts Relating to the Sale and Delivery of Coal (C G–March 15.) 3500 w.

*30395. The Production of the Precious Metals. Editorial (M J–March 16.) 1800 w.

30525. Sixty-eighth Meeting of the American Institute of Mining Engineers, Florida, with Abstracts of Papers and Editorial (E M J–March 30.) 7000 w.

30577. The Health of Miners (A S–March 30.) 800 w.

*30625. A Walk in a Coal Forest. J. William Dawson (C G–March 22.) 2500 w.

30697. Southern Mineral Wealth—Description of Exhibit to Be Made at Atlanta (M R–April 5.) 2500 w.

30754. Compressed Air for Pumping. Frank Richards (E M J–April 6.) 1900 w.

30755. Silver Mining and Smelting in China (E M J–April 6.) 1500 w.

*30793. Diamond Washing and Concentration. Editorial (M J–March 30.) 1800 w.

Serials.

20413. Mining Methods. Ill. (C E–Began March, 1894—14 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E–Began March, 1894—14 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E–Began March, 1894—14 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E–Began March, 1894—14 parts to date—30 cts. each).

21814. Plate Moulding. J. Horner (P Eng–Began April 27, 1894—15 parts to date—30 cts. each).

22586. The Mineral Hydrocarbons. Henry G. Hanks (M S P–Began June 2—25 parts to date—15 cts. each).

22710. Science for Ironmongers (Irm–Began June 2, 1894—18 parts to date—30 cts. each).

24036. Metal Mining.—Underhand and Overhead Stoping Systems. Ill. Albert Williams, Jr. (C E–Began Aug.—5 parts to date—30 cts. each).

27329. Coal-Mining Economy Up to Date (I C T–Began Nov. 23—11 parts to date—30 cts. each).

27450. Cupola Tuyeres. Edward Kirk (Met W–Began Dec. 8, 1894—6 parts to date—15 cts. each).

28786. The Mineral Wealth of Siberia (M J–Began Jan. 19—10 parts to date—30 cts. each).

29468. The Cyanide Process.—Its Practical Application and Economical Results, A. Scheidel (M J–Began Feb. 9—7 parts to date—30 cts. each).

29599. Mining in Spain (Asturias). Anon. (M J–Began Feb. 16—2 parts to date—30 cts. each).

29753. The Sampling and Measurement of Ore Bodies in Mine Examination. Edmund B. Kirby (E M J–Began March 2—Ended March 16—3 parts—15 cts. each).

2,815. Geology of the South-East Portion of the Congo Basin and the Metalliferous Deposits of Katanza. J. Cornet (C G–Began Feb. 22—Ended March 22—5 parts—30 cts. each).

29817. Recent Developments in Coal Mining in Japan (Eng L–Began Feb. 22—Ended March 1—2 parts—30 cts. each).

29939. Pocket Hunting in California. W. H. Storms (M S P–Began March 2—2 parts to date—15 cts. each).

29988. A Review of the Coal Dust Question. James Ashworth (C G–Began March 1—3 parts to date—30 cts. each).

30009. Down in a Belgian Coal Mine. B. Lippens (C Eng–Began March—1 part to date—15 cts).

30047. Prospecting.—Where and How to Find Gold and Silver Veins and Deposits. Ill. Arthur Lakes (C E–Began March—1 part to date—30 cts).

30049. Mine Surveying.—Latest American Ideas and Most Approved Practice. Edward B. Durham (C E–Began March—2 parts to date—30 cts. each).

30214. Modern Coke Making. William Bowron (T–Began March 15—2 parts to date—15 cts. each).

30250. Refractory Gold Ores of Queensland. E. A. Weinberg (A M S–Began Jan. 26—3 parts to date—30 cts. each).

30394. Auriferous Resources of Victoria. H. Armytage (M J–Began March 16—Ended March 23—2 parts—30 cts. each).

30461. The History of Iron. Notes from Dr. Ludwig Beck (Ir Age–Began March 28—2 parts to date—15 cts. each).

30484. Characteristic Features of California Gold Quartz Veins. Waldemar Lindgren (M S P–Began March 23—1 part to date—15 cts.)

30791. Gold Mining in Wales. Anon. (M J–Began March 30—1 part to date—30 cts.)

30815. Furnaces for Roasting Gold-Bearing Ores. Ill. C. G. Warnford Lock (I C T–Began March 29—1 part to date—30 cts).

MUNICIPAL ENGINEERING

Depth of Sand in Filtration.

GRACE C. FRANKLAND, joint author with Prof. Percy Frankland, St. Andrew's University, Dundee, Scotland, of "Micro-Organisms in Water," contributes important observations relating to sand filtration to *Engineering News* (March 14). Quoting the researches of Dr. Percy Frankland, and later those of Reinsch, the author points out that the depth of sand filtration is a potent factor in the efficiency of this means of removing bacteria. The experiments of Reinsch are particularly conclusive as establishing this proposition. "To test this point in more detail, he (Reinsch) drew off the water as it passed through the sand-bed at various depths, commencing immediately beneath the layer of slime at depths varying from 60 to 920 mm. (2.36 to 36.2 in.) One example is sufficient to indicate the nature of the results obtained. The untreated water contained 36,320 microbes in 1 cu. cm. After passing the layer of slime, there were 1876 per cu. cm. found, whilst, after traversing the whole column of sand, there were only 44 in 1 cu. cm. Thus, although after passing through the layer of slime a very large reduction is effected in the microbes present, yet the filtrate still contains bacteria in numbers altogether inadmissible in a properly-filtered water. These results are of importance, as there is a tendency at the present time to attribute too exclusive an importance to the slime and ignore the depth of sand material. Reinsch does not mention the investigations made during the past years at the Zurich water-works, where it was also found that to reduce the depth of sand was to damage the filtrate, and that, in consequence, the layer of sand should never be allowed to sink below 30 cm. (practically 1 ft.). Reinsch, in his conclusions, states that the column of sand, to produce a good filtrate, should never be less than from 40 to 60 cm. (15 to 24 in.) deep. In order to encourage the formation of surface slime, the filters at Altona, after the water is run on, are left undisturbed for 12 hours, and Reinsch states that the neglect of this simple precaution exercised an important influence on the filtrate. These investigations were carried on at the Altona water-works over a period of 18 months, during which time daily samples were bacteriologically examined from each individual filter-bed. In this manner the working of each filter was under constant surveillance, and any abnormally high numbers in the microbes present in any filtrate was at once noted and its cause investigated, thus enabling a bad filtrate to be at once rejected before the whole supply had become deteriorated or endangered by its admixture."

The author adds that the recrudescence of cholera at Altona was ascribed by Koch to the insufficient working of one of the sand filter-beds, this fact not being detected till the whole water-supply had become infected. An important feature of sand-filters insisted upon by Dr. Reinsch is the provision of facilities for sampling the water at different depths, which, he states, can now be done only with extreme difficulty in many of the older beds.

Making and Paying for Parks.

A NEW journal of practical information for municipalities and counties and for those whose business comprises commercial transactions with municipal and county officials is published monthly at Buffalo, and has reached its sixth number. It is a nicely-printed, bright-looking paper and it is named *The Municipality and County*. Sampling its contents, we find an unsigned article, "Making and Paying for Parks," which gives information about the parks in some fifty or more cities of the United States. "Just as the industrial revolution of the past 50 or 75 years has centralized humanity into large cities, so we must now gather the beauties, advantages, and blessings of inanimate nature into small portions of those cities. A park, then, must be something that will furnish to these condensations of population (in a proportionately condensed manner) the essentials of life in the country,—*i. e.*, fresh air, trees, grass, and flowers,—and the greater this density of population, the more urgent the necessity for the parks."

New York is spoken of as a city in which the condition calling for parks exists preëminently. "A sub-committee of the 'Committee of Seventy' reports that in one section there are within a radius of half a mile 250,000 people who live out of sight and out of reach of a green spot. In one block there are 2628 persons on an area of 1¾ acres, being at the rate of 1526 persons to an acre. If residents of cities where it is usual for one small house to occupy say 1-5 of an acre, thus giving say five families or perhaps twenty-five persons to the acre, can grasp the force of these figures, they will realize what we mean by saying that in New York is to be found the condition which reaches an ideal point of necessity for parks,—*viz.*, the presence of a multitude of people, and the absence of open country."

The most valuable part of this article is, however, a summary of information obtained during the past winter in reply to a circular letter of Capt. G. J. Fieberger, acting for the park commissioners of Washington, D. C. The following queries were put to and answered by officials of fifty-one cities. From the replies it is found that forty-five cities do not assess adjacent or abutting property,—to wit, Albany, Alleghany (Pa.), Atlanta, Baltimore, Bridgeport, Buffalo, Cleveland, Cincinnati, Davenport (Ia.), Denver, Des Moines, Detroit, Elizabeth (N. J.), Erie (Pa.), Evansville (Ind.), Los Angeles, Louisville, Lowell, Lynn, Manchester (N. H.), Memphis, Mobile, Nashville, Newark, New Bedford, New Haven, Oakland, Omaha, Pittsburg, Richmond (Va.), San Francisco, Scranton, Springfield (Mass.), St. Joseph, St. Louis, Syracuse, Toledo, Trenton, Troy, Utica, Wilmington (Del.), and Worcester.

Cities which do assess adjacent property are: Boston, Brooklyn, Cambridge, Minneapolis, Kansas City (Mo.), and St. Pau Minn. Boston has the curious system of assessing lands around parks within distances varying from 200 ft. to 600 ft. In Brooklyn Prospect Park "was made a charge against the twelve wards which composed the old city." Kansas City has the system of submitting to a jury the determination of what assessments against property adjacent to parks are equitable. St. Paul assesses 60 per cent. against adjacent property, the distance from the parks wherein such assessments are made depending upon circumstances. In Denver an attempt is on foot to divide the city into park districts. Baltimore exacts 9 per cent. of the gross receipts of street-railways for park purposes. These facts indicate entire lack of uniformity in methods of raising money for parks; but it is added that "mayors and park commissioners are getting together," and it is hoped the "view of the entire field" supplied in this article "will furnish a ground-plan upon which officials can build a more uniform system."

Purifying Sewage and Water by Aeration.

A METHOD of purification claimed to be effective, not only for sewage, but for water also, has recently been experimented with at St. Louis. An account of the method, written by Mr. J. H. Curtis, was printed in *Engineering News* (Feb. 27). Mr. Curtis, speaking of the experiments with sand filtration carried out by the Massachusetts State Board of Health, says that "sand is only a means to an end," and asserts in substance that it is the aeration which takes place during filtration that is the real agent in effecting the desired purification. *Engineering News*, having submitted the proofs of the article by Mr. Curtis to Mr. Geo. W. Fuller, biologist-in-charge of the Lawrence Experiment Station of the Massachusetts State Board of Health, also prints a letter from Mr. Fuller, quoted below. Mr. Curtis describes the St. Louis experiment as follows:

"Aeration was employed, in which the liquid to be treated is absolutely disintegrated or reduced to spray. At the same instant of time, and in juxtaposition with the liquid spray, there must be an atom of disintegrated air. What is the result? Organic matter accompanying the liquid is at once seized by the different constituents of the air, and there are produced pure water and harmless inorganic compounds. How performed? By a screen floor, say, with pepper-box perforations, over which is a layer of coarse river sand, somewhere below another layer of sand, leaving an air chamber between the two. Then, to duplicate nature, cause a rain storm of the liquid to be purified by forcing air into the chamber of a little less pressure than what is sufficient to sustain the weight of the liquid in the tank. These drops, falling on the fine sand, which must be kept unsubmerged, are then and there purified. The perfect disintegration of air and liquid is mechanically performed by the sieve action of the top filament (?) of sand. In this way from 6,000,000 to 15,000,000 gallons of liquid can be treated per acre per day. The lower air-screen is self-purifying, and can be made of any necessary depth to perform the work. In cases of very strong sewage or very much polluted water, additional sand screens have been suspended in the air chamber, grading the sand to a finer quality from the top screen downward. This method disposes of the sludge question. Also aspirators have been attached to the perforated floor, discharging air to the surface of the primary screen, from which the excess air is returned to the chamber by the descending liquid. The aspirators were used with fine gravel. They serve to agitate the surface and prevent clogging."

Some remarks as to the necessary qualities of the sand and some special details of the apparatus are omitted, since, if Mr. Fuller's opinion is authoritative, the whole scheme is fallacious. Mr. Fuller writes:

"The reference by Mr. Curtis to the reports of the Massachusetts State Board of Health on the purification of sewage by intermittent filtration where artificial aeration is used for the removal of air in the filters shows such a complete misapprehension of the process of purification by bacterial action, as well as misconception of the results of our work, that it is difficult to comment on the statements in his letter. He has entirely missed the idea of purification in the series of intermittent sewage filters Nos. 12A, 15B and 16B, which have been described in our reports for 1892 and 1893. It seems to me unnecessary to comment on his scheme until he has some facts to give with regard to the bacterial and organic purification of water and sewage by his system."

More About Acetylene.

THIS illuminant was made the subject of discussion at the twenty-fifth annual meeting of the New England Association of Gas Engineers, held in Boston February 13 and 14, the proceedings being printed in *American Gas-Light Journal* (March 11). Perhaps it would be as accurate to say that the advantages of calcium carbid as a gas-making material was the matter under discussion, since the value of acetylene (obtained from calcium carbid by treatment of the latter with water) as an enricher was admitted by all who took part in the debate. The facts brought out may be summarized as follows:

Acetylene is one of the illuminating principles in both coal-gas and water-gas, the amount of this substance present in commercial illuminating gas being less than 1 per cent. Gaseous acetylene has a specific gravity of 0.91, air being the standard of comparison. Water absorbs about its own volume of the gas. At a temperature of 32° F. it is reduced to a liquid by a pressure of about 50 atmospheres. The specific gravity of the liquid so produced is 0.4, water being the standard of comparison. Thus, while the gaseous acetylene is nearly as heavy as air, liquid acetylene is less than half as heavy as water, bulk for bulk. While the combustion of 1 cu. ft. of coal-gas or water-gas gives from 500 to 600 British thermal units, the combustion of gaseous acetylene produces 1500.

One of the speakers present, Mr. Hinman, remarking upon the claim that a light of 240 c. p. is produced by a consumption of 5 ft. of acetylene gas per hour, thought this was possibly too large an estimate. One objection to the use of acetylene as an illuminant, stated by this speaker, is that it forms a compound with copper and attacks all brass fittings, the substance thus formed being explosive. Should it come into extensive use, this will probably necessitate a modification of gas fittings at present in vogue, and some material not containing copper will be employed for fixtures. Another objection is that its illuminating power, compared to its heating power, is so large that, though it might be economical for lighting, it could not be used economically for heating, the latter being an increasing and important application of gas for domestic purposes.

An interesting illustration of the formation of an explosive substance by the action of acetylene on copper was presented by Dr. Wilkinson. He said that "in the old gas works a good deal of copper tubing was used, and it was noticed that there was deposited inside of the copper tubing a compound which, when it was struck by a hammer, would explode. After that, people were very careful in handling the old copper tubing from gas works, for it would explode almost like gunpowder, when struck or when heated. Acetylene also forms an explosive compound with silver. These are all well-known explosive compounds. But in our ordinary works I do not think we need anticipate any trouble from that source, as the small amount of copper that we have in our stopcocks would not be sufficient to cause any difficulty. The use of copper piping about our works is a thing of the past. So in that respect I do not think we have anything to fear."

Dr. Wilkinson also stated that the promoters of acetylene as an illuminant expect to make it cheaply enough to render it commercially practicable. "They say, for instance, there is a great water power at Niagara Falls; they may use that at night, and then for 6 or 8 hours every day the power is idle; wherefore, if we can make the carbid during the day, we can possibly make it very cheaply. As regards its competing with naphtha, you will see that, if it is $5 or $10 per ton, you can compare that with cannel coal at $10 per ton, from which you get about the same quantity of gas. Of course cannel coal will not enrich in proportion anything like what this substance would. As an enricher for water-gas it has been a disappointment to all of us. With 10 per cent. of acetylene in water-gas the gas burns blue; 20 per cent. gives you a little better light; while 40 per cent. gives you a beautiful light. There you see that it is of no use." While this material is so inefficient an enricher for water-gas, an addition of 2 or 3 per cent. to coal-gas, the speaker said, raises the latter from 16 to 20 c. p., and at the same time produces a clear white light.

European Reservoirs for Water Supply.

In "Notes on European Water Supply," Mr. Allen Hazen, of the Boston Society of Civil Engineers (*Journal of Engineering Societies*, February), among a variety of interesting particulars, says that in constructing water-works provision is made nowhere in. Europe for a supply of one-half, and frequently for a supply of not more than one-fourth, the quantity per head that is "considered necessary for American communities. The causes of this difference are not altogether clear. In some instances the smallness of the European consumption may, in a measure, be attributable to a smaller proportion of water-closets, or to the fact that the entire population is not provided with flowing water in private apartments. But, after making all possible allowance, there is still a wide discrepancy which cannot be accounted for by the greater comforts or cleanliness of the American cities. Fire protection in Europe is upon a radically different basis from that in America. In all European capitals the construction of other than fireproof buildings is strictly prohibited, and fires, as we understand them in America, can hardly be said to exist. In Berlin, during the past year, the quantity of water which supplied all the necessities of the fire department for extinguishing fires and other purposes was less than three thousand gallons daily, and in no other German city, except Hamburg, was so large a quantity required." Water meters are said to be much more generally used in European than in American cities, and this fact undoubtedly prevents waste.

Sewerage in Foreign Cities.

"SEWERAGE IN FOREIGN CITIES" takes up about 100 pages of "Consular Reports" for February, 1895. At the request of the Sanitary Board of Savannah the State Department in July, 1894, sent a circular to the consular offices in the principal cities of Europe, requesting information on certain specified points in relation to the sewerage systems of those cities. Replies were received from Amsterdam, Berlin, Bordeaux, Bradford, Bremen, Brussels, Cardiff, Constantinople, Copenhagen, Dublin, Edinburgh and Leith, Florence, Frankfort, Glasgow, Hamburg, Havre, Leeds, Liverpool, Lyons, Manchester, Marseilles, Munich, Rome, St. Petersburg, Stettin, Stockholm, Trieste and Vienna, and are included in the publication mentioned above. Some of the replies—says *Engineering News*—were prepared with care from official reports and contain recent information, in some cases, regarding a number of European sewerage systems, which is not available elsewhere, and may be interesting to some, although written from a popular rather than an engineering standpoint. For copies of the issue of "Consular Reports" containing this matter the Bureau of Statistics, Department of State, Washington, D. C., may be addressed.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Gas Supply.

30006. Carbide of Calcium.—Its Advantages as a Gas Making Material and as an Enricher.—Discussion at Meeting of New Eng. Asso. of Gas Eng. (A G L J–March 11.) 3500 w.

30008. Welsbach Street Lighting in Budapest. Isador Bernauer (Am & I W–March 8.) 400 w.

*30035. Life in the Far East. From a Gas Manager's Wife's Point of View. Mrs. A. Smith (G W–March 2.) 3800 w.

30060. Gas.—Its Production and Relation to Foundries. Arthur Kitson (Ir Age–March 14.) 2400 w.

30145. The Key to the Welsbach Problem. Charles G. Burton (E E–March.) 1700 w.

*30212. Relative Cost of Gas and Electric Light Works (J G L–March 5.) 2000 w.

*30289. Gas Workers and Old-Age Pensions. Anon. (J G L–March 12.) 2200 w.

*30290. Carburetting by Benzol. Ill. (J G L–March 12.) 1000 w.

30400. The Best Way to Burn Gas for Lighting Purposes. C. R. Bellamy (A G L J–March 25.) 3300 w.

30401. Carbide of Calcium. Henry L. Doherty (A G L J–March 25.) 1500 w.

30402. Changing the Arrangement of a Retort House and the Practical Results Derived Therefrom. A. F. Nash (A G L J–March 25.) 1200 w.

30403. Prepayment Gas Meters. John D. Mc Ilhenny (A G L J–March 25.) 3200 w.

30404. Cannel Coal as an Enricher. Graham Macfarlane (A G L J–March 25.) 1300 w.

*30413. On the Manufacture of Acetylene. Anon. (G W–March 16.) 1800 w.

30471. Acetylene Apparatus. T. O'Conor Sloane (Sc A–March 30.) 700 w.

30474. Acetylene for Gas Purposes. Dr. Wilkinson (Sc A S–March 30.) 1500 w.

30536. Soft-Coal Water Gas. W. S. Bowen (A G L J–April 1.) 2800 w.

30537. Carbide of Calcium. W. W. Goodwin (A G L J–April 1.) 3500 w.

30545. Comparative Measurement of Different Incandescent Burners. W. Wedding (A M & I W–March 29.) 1200 w.

*30579. The Distribution of Gas (J G L–March 19.) 1900 w.

*30580. Gaseous Fuel in the Retort-House. Ill. T. S. Cleminshaw (J G L–March 19.) 2300 w.

*30581. Acetylene as an Illuminating Gas.—A German View of the Subject (J G L–March 19.) 800 w.

*30606. The Real and Alleged Defects of Flueless Gas Stoves. Thomas Fletcher (G W–March 23.) 3500 w.

*30701. Explosions in Electric Light Culverts. F. C. S. (J G L–March 26.) 1000 w.

30753. Is This a Possible Rival of Electricity for Illumination? C. C. Haskins (W E–April 6.) 1500 w.

*30789. The Cause of Luminosity in the Flames of Hydro Carbon Gases. Vivian B. Lewes, with Editorial (G W–March 30.) 9000 w.

30800. Discussion of Mr. Nash's Paper—"Changing the Arrangement of a Retort House, and the Practical Benefits Derived Therefrom" (A G L J–April 8.) 3000 w.

30801. Discussion of Mr. Bowen's Paper——"Soft Coal Water Gas" (A G L J–April 8.) 1200 w.

30802. Discussion of Mr. McIlhenny's paper "Prepayment Gas Meters" (A G L J–April 8.) 1200 w.

30803. Discussion Concerning Incandescent Burners (A G L J–April 8.) 5000 w.

Sewerage.

29974. Sewage Disposal Works, New

Rochelle, N. Y. Ill. (E R–March 9.) 1400 w.

Streets and Pavements.

30065. MacAdam's Method of Road Building. From the St. James Gazette (E & C–March 8.) 1000 w.

†30326. Vitrified Brick for Street Pavements. T. W. Gibson (S M Q–Jan.) 11200 w.

*30632. Injurious Manipulation of Asphalt. F. A. Hetherington (P–April.) 1200 w.

*30633. Some Tests of Paving Brick. James W. Reed (P–April.) 1300 w.

*30636. Paving Brick in Ontario.—From Report of the Bureau of Mines of Ontario (P–April.) 1500 w.

30709. The Perkins Surface Heater for Repairing Asphalt Pavements. Ill. (E N–April 4.) 1400 w.

Water Supply.

29973. Submerged Cast Iron Pipe Line, Portland, Ore. (Abstract.) Franklin Riffle and Albert S. Riffle. Published in T. C. E. (E R–March 9.) 1800 w.

*29986. London Water Supply. Editorial (E–March 1.) 4600 w.

30106. Auxiliary Supply of the Water-Works of Addison, N. Y. Ill. H. F. Labelle (E N–March 14.) 800 w.

30109. Depth of Sand in Filter Beds Necessary to Remove Bacteria. Grace C. Frankland (E N–March 14.) 700 w.

30130. New Water Works and Lighting Plant, Winchester, Va. Ill. (E R–March 16.) 1300 w.

*30191. Floods and Frost. Anon. (Eng L–March 8.) 2400 w.

*30193. Official Reports on the London Water Supply. Editorial (Eng L–March 8.) 1900 w.

*30292. Notes on European Water Supplies. Allen Hazen (J A E S–Feb.) 7000 w.

*30293. The Lake Vyrnwy Water Supply for Liverpool. Thomas M. Drown (J A E S–Feb.) 1200 w.

30359. The Oberlin, O., Water Tower. Ill. (E R–March 23.) 500 w.

*30368. Frost and Water Supply. Editorial (Eng L–March 15.) 1900 w.

30507. Proposals for a New Water Supply for Jersey City (E N–March 28.) 700 w.

30521. Gas Engines for Water Pumping. Ill. (E R–March 30.) 2700 w.

*30594. The Water Supply of Belfast. Ill. Hary Wimborne (Eng L–March 22.) 2800 w.

30598.—75 cts. Eternal Vigilance, the Price of Good Water. G. F. Chace (J N E W–March.) 1700 w.

30599.—75 cts. The Capacity of Steam Fire Engines, Hydrants and Hose. Dexter Brackett (J N E W–March.) 2500 w.

30600.—75 cts. A Few Examples of High Grade Pumping Engines. Ill. E. D. Leavitt (J N E W–March.) 7400 w.

†30631. The Long Island Water Basin.—Brooklyn's Reservoir. A. N. Bell (San–April.) 1400 w.

†30651. Artesian Water in Western Queensland. (Abstract.) R. L. Jack, with Editorial. (Australasian Pastoralists' Review–Feb. 15.) 7000 w.

†30693. Raj. Rajeswari Water Works, Nasirabad, Mymensingh. Ill. (I E–March 2.) 600 w.

30717. Dam No. 5 for the Additional Water Supply of Boston. Ill. (E N–April 4.) 400 w.

30735. Water Meter Experience in Detroit. (E R–April 6.) 1400 w.

30737. Forests and Water Supply. (Extract.) John Birkinbine (E R–April 6.) 1300 w.

Miscellany.

*29960. Parks, Parkways and Pleasure Grounds. Frederick Law Olmsted (E Mag–May.) 3000 w.

30146. The Science of City Government.—Review of book by Albert Shaw. Fred De Land (E E–March.) 2200 w.

*30201. Making and Paying for Parks Ill. Anon. (Municipality and County–March.) 2000 w.

*30373. The World's Debt to Modern Sanitary Science. John S. Billings (Ch–April.) 3500 w.

30412. The Work of Women in Village Improvement. Editorial (G & F–March 27.) 1000 w.

30506. The Arnold System of Garbage Utilization at Boston. Ill. (E N–March 28.) 2500 w.

†30629. Domestic Garbage Disposal.—The Household Carbonizer. Ill. W. F. Morse (San–April.) 1300 w.

†30630. Stable Manure and Manure Disposal in New York. Report of Committee (San–April.) 5500 w.

*30634. How to Prevent Electrolysis of Gas and Water Pipes. Udo Hesse (P–April.) 1500 w.

*30635. The Duties of a City Engineer. Horace Andrews (P–April.) 3200 w.

†30670. San Francisco and the Civic Awakening. Adeline Knapp (A–April.) 3500 w.

30715. The St. Louis System of Controlling Municipal Engineering Work (E N–April 4.) 2700 w.

Serials.

20466. Details of Modern Water Works Construction. Ill. Wolcott C. Foster (S M Q–Began Jan. 1894—3 parts to date—45 cts. each).

28265. Frontinus on the Water Supply of Rome, A. D. 97 (E R–Began Jan. 5—5 parts to date—15 cts. each).

30134. Municipal Responsibility for Damage from Fire Apparatus. Andrew J. Sanford (F W–Began March 16—2 parts to date—15 cts. each).

30399. Studies in Carbide of Calcium. M. P. Wood (A G L J–Began March 25—Ended April 1—2 parts—15 cts. each).

RAILROADING

Hardie's Compound Air Car Motor.

FROM 1877 to 1881 two accomplished Scotch engineers (one of whom died shortly after the period named) were in this country designing and putting into operation a compressed-air motor for street railways. The result of their efforts was a motor which ran with ease the distance from Sixty-ninth street to City Hall, New York, and return,—about 10 miles. The writer of this review rode from City Hall to Sixty-ninth street on one of the first trial trips. There were some imperfections in the motor as then constructed, but in the main it embodied the features of a good machine. It seemed to need nothing but the application of lessons to be learned only by experience to render its operation satisfactory in all respects. This was one of a number of pioneer efforts made about that time to supply a motor for street-car traffic that could take the place of animal traction. One of the two engineers who designed this motor, Mr. Robert Hardie, has been at Rome, N. Y., during the past year, engaged in designing a new compressed-air street-car motor.

These inventors had the misfortune, in the first instance, of being ahead of the age. The necessity for other motors than horses or mules for moving street cars has since become so pronounced, and the means for meeting the demand by electric and cable propulsion have so completely proved the feasibility of the substitution, that horse cars have almost disappeared. Neither cable traction or electric traction are, however, satisfactory in all respects. The period of transition is still on, and the present is, perhaps, as good a time as will ever come to introduce a good street-car motor. Most engineers who know Mr. Hardie personally will feel confident that, if there exist in compressed air the possibilities of a good car-motor, his experience and knowledge render him just the man to produce it. And we think few who have had extensive experience with compressed air as a motive power in other machines will doubt the possibilities. At any rate Mr. Hardie has, we understand, secured a substantial backing, and has constructed and brought to trial a promising motor.

The *Scientific American* (March 16) gives an account of the trial recently made at Rome, N. Y. "The trial was made on the 800 ft. of rough track in the yard of the works, with Engineer Williams at the lever. The car started out with 1800 lbs. of air pressure to the square inch and a temperature of 310 degrees on its hot-water tank, which is used to great advantage in heating the air before it passes at reduced pressure to the engine cylinders. A valve constructed for the purpose reduces the pressure of the stored air to 140 or 150 lbs., and this is the working pressure, or the pressure at which the air enters the engine cylinders. The motor starts gently, runs smoothly at a rapid rate, and stops by air brake without jerk or jar. It was run back and forth repeatedly for upward of forty trips, and the test showed that under the conditions applied the motor would run 12 miles from one charging of compressed air, and make seventy stops.

"The method of recharging the storage cylinders with compressed air was shown. It is a very simple operation, and, with the flexible couplings contemplated for the purpose, the recharging of a car with power need not occupy more than a minute or two. The same is true as to recharging with hot water, and the two can be done at the same time. The temperature of the hot-water tank, covered with asbestos, on the occasion of the trial, was reduced from 310° F. to about 200° in one working hour. Under more favorable circumstances, especially in summer, this reduction would be much less,—probably not more than half as much.

"The Hardie motor and car are hung on elliptic springs, and the ease with which the car passes over wide joints, frogs, or imperfections in the track is something admirable. This very important feature attracted the attention and favorable comment of the inspecting visitors from the East, all of whom know too well the terrible pounding that the trolley car gives the railroad track, because, like the lumber wagon, it is absolutely without springs. In this respect the Hardie motor indicates a sure and great saving in wear of rails and cars, while affording the utmost ease to passengers riding."

The main features of the motor are the storage of air under high pressure in tubular tanks which deliver their air to compound engines having reversing valve-gear. The air is reheated during its passage to the engine cylinders. The storage tanks (analogues of the steam boiler of a locomotive) are filled from a tank of compressed air at stations, the stationary tank being supplied constantly by a powerful air compressor.

The trial appears to have satisfied men interested in car-propulsion that the new motor is a good one. The *Scientific American* says, on the authority of the Rome *Daily Sentinel*, that, as the results of the trial, an order was given "for the construction of six to ten of the motors to be used on eastern lines. The order is upon certain conditions, one of which is the introduction of Pintsch gas light into the cars. This, Mr. Hardie says, can easily be done, and other mechanical requirements can easily be met." The losses between prime motor and delivery of power to the car-motors are claimed to be less in this system of propulsion than in either cable or electric traction.

Railroad Discipline.

In connection with the able papers by W. H. Caniff (" Relations of the Railway to its Employees ") and Cy Warman (" Relations of the Employee to the Railroad ") published in our March number, another paper, in line with these, by Mr. F. G. Darlington, superintendent of the Pittsburgh, Cincinnati, Chicago, and St. Louis Railway (read by the author at the meeting of the Central Association of Railroad Officers in Columbus, Ohio, Feb. 19), is timely. The paper is of a practical character, dealing with a system of discipline now in force on the Indianapolis division of the above-named railway. It is stated that this system is a modification of the disciplinary system in use on the Fall Brook Railway.

The distinguishing and underlying principle of the system is that of justice to both the company and the men, and to this end records are kept, which show not merely neglect, but also meritorious performance of duty. Mr. Darlington calls this a system of "debits and credits," which affords every man " a true record of his service. Every neglect of duty, instruction, etc., is promptly investigated by the head of the department concerned. Most cases involve the employees of more than one department, and therefore require a joint action by two or more officers. If the case is of a trivial nature, and the facts clear, the officer or officers who make the investigation present the facts (in writing) to the superintendent, and suggest the extent of the discipline. If the examination of the offender's previous record does not show reasons for increasing or diminishing the extent of discipline, the suggestion is approved by the superintendent, and a bulletin is prepared. All cases, except those of a trivial nature, are personally investigated by the superintendent, with the assistance of the head of the department in which the person is employed. If the case involves enginemen, conductors, and questions of train movement or orders, the chief train dispatcher is present and assists in the examination of witnesses; also the road foreman of engines, and the trainmasters. The examinations are recorded by a stenographer. After a case has been investigated, discussed, and the discipline decided, a bulletin is prepared under the direction of the superintendent, containing a concise summary of the facts and discipline imposed. A duplicate copy of the bulletin is forwarded to each officer in charge of a bulletin case, a copy is sent (under personal cover) to the employee disciplined, and record is made in the record book. All papers, reports, etc., of each case are filed for future reference.

The record book is indexed by name; each employee has two opposite pages, so that any person may examine his own record without seeing that of any other employee."

Much time and labor have been involved in carrying this system into regular operation. The preparation of the bulletins necessitates much care. The same may be said of the records. Gross inaccuracy would, of course, render the system entirely worthless. The advantages, however, as stated by Mr. Darlington in the following quotation, would seem to compensate a good deal of effort.

"(1) To avoid loss of time and the consequent possible suffering to those who may be dependent upon the person disciplined. Loss of earnings thus prevented may mean the reform and improvement of many who would, if suspended, develop habits inconsistent with their duties. (2) That all may become acquainted with every case for which discipline is imposed, and learn the lesson from failure of others. (3) The steady employment, which reduces the number of extra men to a minimum, and so avoids the dangers incident to the use of inexperienced persons. (4) By placing the facts before all concerned the evils of misrepresentation are eliminated. (5) Inaccuracy of record is prevented, because any mistake will be promptly reported by those concerned. (6) The necessity for more thorough and systematic care in making investigations leads to a closer relationship between the officers and employees,—a condition which produces coöperation for the best interests of the company.

"The bulletin is a terse form of the record. The form of bulletin is such as to reduce to a minimum the opportunity for employees to discover the name of the person disciplined, the object of the bulletins being to caution all who might commit a similar error. There is no advantage in advertising the names of those who receive the discipline. By furnishing each person disciplined a copy of the bulletin of their case, and by their knowledge of the record made, the effect is better than to humiliate by enabling others to know names. After a bulletin has remained in the case 10 days, it is removed and pasted in the gummed file book. The bulletins are consecutively numbered. The file of bulletins at the headquarters of each bulletin-case enables the employees to examine or study all cases. Bulletin cases are located with the idea that they will be used exclusively by the employees of the Indianapolis Division. Whenever agents, operators, section men, shop employees, and others are disciplined, a copy of the bulletin is sent to each person interested who may not have access to the bulletin-case."

Street-Railway Wheel-Treads and Flanges.

THE questions whether a standard for street-railway car-wheels is desirable, whether practicable, if desirable, and, if both desirable and practicable what it should be, have been presented for serial discussion in the *Street Railway Review* (Feb.). In this series of papers will be presented the views of the principal street-railway companies in the United States. It appears that very great diversity exists in practice as regards flanges and treads, and that the adoption of a uniform standard would ultimately result in cheaper wheels. It is likely that the discussion will elicit much information as to the reasons for the existing diversity.

"One man wants a thin, shallow flange, because he is operating on a grooved rail. How many roads in this country are operating over a grooved rail that requires a very thin, shallow flange? Not 1 per cent. Another wants a deep flange for conditions approximating steam road practice. Is there any evidence more than a theory that such deep flanges are a necessity? If there is, it should be unearthed. Another objection is that some want a broad tread, and others a narrow one. Practice favors a tread the same width as the rail-head. If this practice is wrong, it should not be used in the standard wheel, and nobody should desire to use it. If it is right, why should there be any deviation from it? In other words, the standard wheel, if adopted, should be a combination of the best teachings of experience. Conditions are not so widely different but that one or possibly two standards can be adopted which will suit all cases. There is absolutely no reason for the greater part of the variations in practice which exist at present. Why should half a dozen roads operating under exactly the same conditions require half a dozen different forms of wheel-flanges and -treads?"

It appears that a consensus of opinion upon the wheel question has never been sought previous to this effort to obtain it. "Every man has his own theory as to what is the proper wheel. Accordingly, there are hundreds of patterns, only a few of which can be of the correct form. One well-known superintendent expressed the opinion recently that a bevel was absolutely necessary to success in street-railway operation, and that, in fact, so dependent is success on the little things, that street-railroading would have been a failure had it not been for the bevel on the wheels. That was stating it rather strongly, especially in view of the fact that some men do not believe in any bevel whatever, and are operating successfully with wheels having a flat tread. It is hard to determine what originally led to the bevel of wheels on steam roads, but very likely it was the greater ease with which they could be drawn from the chills in which they are cast. The efficacy of the bevel is by no means established. On the anti-bevel side may be mentioned some of the large systems of St. Louis and the Denver Tramway company. The opposite extreme is represented by the Chicago City Railway, which has a very large bevel on its wheels, and is laying beveled rails to correspond. So it will be seen that, on one of the first and most important points to come up when the question of a standard wheel-tread is broached, there is a difference between the best of authorities. Which is right? A standard ought to be adopted, if for no other reason than to cause an investigation as to what is actually the best wheel-tread and -flange. The rail-heads used by street railways, whether on T-, girder-, or grooved rails, are now nearly all of the same shape as regards the part on which the wheels and flanges have contact. Girder-rails are flat headed, and modern T-rails are the same. There is, therefore, not the difficulty of a variety of rail-heads to stand in the way of this reform." Some of the letters on the subject from railroad men indicate that the subject will be of general interest, and that the discussion is well-timed.

Street Railway Motormen and Car Repairs.

In an article on this subject by Harry F. Reynolds, in *Street Railway Review* (March), the extent to which an incompetent or careless motorman runs up costs for repairs for the company employing him, and the way in which a good motorman keeps down costs of repairs, is well set forth. In the case of two cars, the one run by a thoroughly competent man, the other by one of the opposite character, the repairs on the car run by the former was $30, while repairs on the car run by the latter was $420. Both these motormen were experienced. One was intelligent, conscientious, and careful; the other reckless, and indifferent to the interests of his employers. Speaking of the car run by this man, the author says:

"In less than one month this car was run off a 20-foot embankment, precipitating car, passengers, and motorman to the bottom, falling on one end, with the passengers, seats, mats, and trap doors, intermingled with broken windows, all in one promiscuous mass. The passengers were extricated from their perilous position with only one injured, and by the use of a small amount of cash and a large amount of diplomacy a damage suit was prevented. The end of the car was smashed, besides all the windows broken. The cost of raising car and repairing was $100. This accident was caused by excessive speed at a dangerous portion of the track. Shortly after this a new man was put in charge of the car; a bolt became broken, and fell in the motor; before it was discovered, the armature was ruined, which cost $160. After retaining this man for more than a year, the cost of repairs became too high, and a new man was substituted. He became ambitious in the start, and in a few weeks disputed the right of way with a switch engine at a railroad crossing and came off *hors du combat*. His car was thrown from the track, with one side demolished and an axle broken; repairs, $100. In less than two weeks after the car was put on again, one morning, when going to the station, the motorman informed me that one of his motors was sparking badly. I looked at it, and found that a bolt had become detached and had torn off the commutator connections of over half of the coils, which were damaged beyond repair; cost of rewinding, $60. The amounts for these repairs are $420, which could, with careful management of the car, have been avoided. Each of these cars had the same mileage, 122 miles per day, over the same track. The loss incurred by this car being in the barn has not been calculated."

Mr. Reynolds does not credit the statement of a Brooklyn street railway manager who asserts that he can make a good motorman out of any man of ordinary intelligence in one week, but believes that the accident and repair account of this road would tell quite a different story. "The man who has charge of the car on which only $30 were expended has become an ideal motorman. He understands his car, and, when he has any time at the end of his run, inspects the motors. If any trifling derangement of the car takes place, he repairs it temporarily, and reports the same at night to the barn foreman. He understands how to start and stop a car, which, I am compelled to say, very few motormen do understand. I desire to say right here, motormen are like poets, 'born, not made,' and no amount of coaching or instruction can make a man understand how to handle a car unless he possesses the natural knack. Some men learn readily, and others not at all; with some men it is not all incapacity, but indifference, thinking they have learned it all, which is as bad or worse. I would rather have a man who tried conscientiously to do his duty and failed, than one who did not care, and failed through indifference, or even over-confidence in his ability."

Mr. Reynolds speaks from the book, his remarks being based on his own experience in the management of a street railway. A short conversation with almost any of the Brooklyn motormen by one who knows a little of the details of electric car propulsion will convince the interviewer that, if ignorance is a factor in cost of repairs, the electric lines of that city must find this item a large one in the total annual expense account.

Train-Robbing.

THAT this variety of crime is on the increase is shown by the following statistics taken from a letter to *The Railway Age* (March 15) by G. W. Agee. In 1890, 12 trains were held up; in 1891, 16; in 1892, 16; in 1893, 33; in 1894, 34,—111 in the 4 years named. In these "hold-ups" twenty-seven lives were lost, and thirty people were injured. Mr. Agee supposes that the people "who are cudgelling their brains at the present day with the hope of evolving some solution of this so-called much-vexed problem would outnumber the standing army of the United States."

Many of the remedies proposed are mentioned only to show their futility, and then the author enrolls himself in the army of remedy-proposers. He proposes that train-robbing should be dealt with in the same manner as the crime of highway robbery of United States mails, for which the penalty is imprisonment for life. The newspapers are also held to be in fault. "In fact, train-robbing is the best-advertised business in America at the present day. The daily press is, unwittingly, a most potent factor in the promotion of this class of crimes. According to modern journalism the routine happenings of life are not news. Hence the tendency to sensationalism and to exaggeration which is so universally indulged by the press. Fabulous sums are heralded in flaming headlines as the booty secured, and the ignorant and unthinking masses, from whose ranks criminals come, are led to believe that large rewards attend the successful accomplishment of this crime.' A number of examples of gross exaggeration of amounts looted from trains which have been printed in the daily press are cited to prove this, and it is asserted that "express companies spend annually ten times more than they lose by these thefts in the pursuit and prosecution of this class of criminals, but, handicapped as they are by inadequate laws, the results do not tend to the suppression of the industry."

In conclusion it is maintained that, while "there is no positive antidote" for train-robbing, its "regulation and suspension demand that express companies should divest the business of train-robbery of all profit by the use of burglar-proof safes; that congress should give, by federal statute, the same protection to all Inter-State commerce as it gives to the United States mails; and that the daily press of the country should not advertise the business of train-robbery, as a paying industry, when the facts, easily accessible, will show that it is not."

ONE of the events looked forward to with interest in railroad circles is the International Railway Congress to be held in London at the Imperial Institute, Kensington, June 26. The American Railway Association, which has now become a member of the International Railway Congress, will be represented by an able delegation of eight representative railway men, two of whom, Mr. H. S. Haines, president of the Association and vice-president of the Plant System, and Mr. W. F. Allen, secretary of the Association and manager of the *Official Railway Guide*, have been named at the present writing. The following railway companies are members of the Congress, and entitled to send delegates on their own account: to wit, "Louisville and Nashville; Pennsylvania; Denver and Rio Grande; New York, New Haven and Hartford; Chesapeake and Ohio; Fitchburg; Richmond, Fredericksburg and Potomac; Arizona and South-eastern; Los Angeles Terminal. The session will be held in the Imperial Institute in Kensington. The last session of the Congress was held at St. Petersburg, Russia, in 1892, and the one before that at Milan, Italy."

Conventions of this kind are significant of the fact that industrial progress is rapidly effacing national boundaries. In engineering, "the field is the world." Aspirants for prominence in the profession are not limited by national prejudices as formerly.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*29992. A New Great Northern Engine. Charles Rous-Marten (Eng L–March 1.) 1800 w.

*29994. Automatic Railway Signalling. Editorial (Eng L–March 1.) 2000 w.

*30001. Steam Tramways in Italy. Ill. P. Amoretti (I & I–March 1.) 3800 w.

*30034. The Light Railway Question.—Interview with Mr. Meik (Tr–March 1.) 2600 w.

30044. Altoona Shops of the Pennsylvania Railroad.—The Freight Car Shop, B. F. Evans (R C J–March.) 3500 w.

30057. The McGann Arbitration Bill. Joseph Nimmo, Jr. (R R–March 9.) 900 w.

30058. Government Ownership of Railway Mail Cars.—From Railway Equipment Guide (R R–March 9.) 1100 w.

30063. Street Car Compressed Air Motor.—Trial of the Hardie Air Motor. From Rome (N. Y.) Sentinel (S C A–March 16.) 700 w.

30067. The Industrial Use of Motors on Power Circuits, Operated by the Street Railway Company at Los Angeles, Cal. Ill. George Heli Guy (E E N Y–March 13.) 3000 w.

30097. Baltimore and Ohio—The Pioneer Railroad—Interesting Sketch of Its Origin and Progress. Ill. (I Age–March.) 1800 w.

30100. Smith's Three-Cylinder Locomotive. Ill. (R G–March 15.) 700 w.

30101. Track Elevation in Chicago (R G–March 15.) 2400 w.

30102. Railroad Discipline. F. G. Darlington (R G–March 15.) 2300 w.

30105. The Design of Locomotives for Fast Passenger Service. Hugh Sharp (E N–March 14.) 1000 w.

30107. Methods of Clearing Away Railway Wrecks. (Extract.) W. L. Derr (E N–March 14.) 1700 w.

30140. The Railways of West Virginia. Anon. (M R–March 15.) 5000 w.

*30148. Street Railway Motormen and Car Repairs. Harry F. Reynolds (S R R–March.) 1600 w.

*30149. A Perfect Rail Bond. Harold P. Brown (S R R–March.) 1800 w.

*30150. New Cable Line of Columbia Railway Company, Washington, D. C. Ill. (S R R–March.) 2500 w.

*30152. Safety Gates at Minneapolis. Ill. (S R R–March.) 700 w.

We supply copies of these articles. See introductory

30153. Train Robberies. G. W. Agee (R A–March 15.) 1500 w.

30154. Protection of Tracks Against Snow. Ill. Extract from Address of James Manning (R A–March 15.) 1500 w.

*30155. Narrow Gauge Railways in the Canton of Geneva. Ill. (R W–March.) 2000 w.

*30156. Six Wheels-Coupled Mineral Engine, North Eastern Railway. Ill. (R W–March.) 200 w.

*30157. Bristol Tramway Cars. Ill. (R W–March.) 1600 w.

*30159. Some Links in Locomotive History. Ill. Clement E. Stretton (R W–March.) 350 w.

*30182. Light Railways. Editorial (E–March 8.) 3800 w.

*30189, Parliamentary Procedure re Light Railways. W. Worby Beaumont and Stephen Selion (I & I–March 8.) 5000 w.

*30230. Ties and Poles for Railway Work. J. H. Godfrey (S J E–March.) 1200 w.

30243. Railway Legislation. Editorial (R R–March 16.) 1200 w.

30244. The Railway Signaling Club. Editorial (R R–March 16.) 1000 w.

30280. The New Railroad Station in Cologne. Ill. (Sc A S–March 23.) 1100 w.

*30294. The United Verde and Pacific Railway. Ill. Elbridge H. Beckler (J A E S–Feb.) 7500 w.

30296. Rapid Transit in Large Cities. March Meeting of the A. S. M. E. Paper by W. B. Parsons, with Discussion (R G–March 22.) 3500 w.

30297. The New St. Albans Freight Yard—Central Vermont Railway. Ill. (R G–March 22.) 150 w.

30298. The Cost of Heating Cars by Electricity. Editorial (R G–March 22.) 900 w.

30299. The Progress of Railroad Reorganization. Editorial (R G–March 22.) 1200 w.

30313. The New Electric Underground Railway in Budapest. Ill. (E N–March 21.) 2200 w.

30316. The New Conduit Electric Railways. Ill. (E N–March 21.) 800 w.

30317. Recent Progress in Railway Car Lighting (E N–March 21.) 1300 w.

30318. Underground or Elevated Construction for the New York Rapid Transit Railway. Editorial (E N–March 21.) 3000 w.

30319. Specifications for Buffalo Grade Crossing Work; N. Y. C. & H. R. R. R. (E N–March 21.) 2500 w.

*30365. Railroading in America. Ill. By an English Railway Engineer (Eng L–March 15.) 2200 w.

*30366. The Jubilee of Express Trains. Anon. (Eng L–March 15.) 1800 w.

*30380. Light Railways. Editorial (P Eng–March 15.) 1100 w.

*30415. The Indian Railways (Tr–March 15.) 700 w.

30430. A Sermon on Transportation. George H. Daniels (R R–March 23.) 2700 w.

30431. The New Rules of Interchange. Editorial (R R–March 23.) 1200 w.

30432. Slope of Cuts. Jerry Sullivan (R R–March 23.) 600 w.

30496. A Suggestion for New York Rapid Transit. Ill. Fr. von Emperger (R G–March 29.) 1000 w.

30498. Automatic Air-Brakes Without Angle Cocks (R G–March 29.) 900 w.

30499. The Santa Fé, Prescott and Phoenix Railway. M. J. Lorraine (R G–March 29.) 1500 w.

30501. Competition of Electric Street Railroads. Editorial (R G–March 29.) 1400 w.

30502. Power and Efficiency of Locomotive Boilers. Editorial (R G–March 29.) 2600 w.

†30527. The Successor of the Railway. Appleton Morgan (P S M–April.) 5000 w.

30528. Electric Railway Power Plant in Allentown, Pa. Ill. (S R G–March 30.) 1200 w.

30529. Rights of Pennsylvania Suburban Electric Railways—Abstract of the Opinion of Judge Williams (S R G–March 30) 1200 w.

30530. In Behalf of Connecticut Electric Railways. Abstract of Judge E. B. Gager's Address (S R G–March 30.) 1800 w.

30542. Adjuncts of a Modern Railroad Station. Ill. Fred. H. Colvin (M A–April.) 800 w.

*30560. Timber Cross Sleepers as Track Gages. Ill. Joseph Anthony (L E–April.) 1200 w.

*30561. Breakage of Axles. Editorial (L E–April.) 1600 w.

*30562. Automatic Air Brakes Without Triple Valves. Ill. Paul Synnestvedt (L E–April.) 1000 w.

*30563. Are Leakage Grooves of Any Use?—Drainage of the Drum and Pipes. Will W. Wood (L E–April.) 2000 w.

*30564. Why Does a Locomotive Boiler Explode When It Has Sufficient Water and Working Under Ordinary Steam Pressure? James Hughes (L E–April.) 1000 w.

*30566. Body Bolsters. Ill. Orville H. Reynolds (L E–April.) 2500 w.

*30596. Tramways on Mountain Roads. Editorial (Eng L–March 22.) 1100 w.

*30597. Electrical Tramway with Underground Conductor.—Lyons Exhibition. Ill. (Eng L–March 22.) 2400 w.

*30601. The Narrow Gauge Delusion. Editorial (A E R J–April.) 3000 w.

*30605. Economic Use of Coal in Locomotive Service. Ecitorial (N C B–April.) 3500 w.

*30609. Mechanical Power on Our Tramways. Philip Dawson (E R L–March 22.) 1200 w.

30611. The Advantages and Disadvantages of a Lock and Block System on a Busy Line of Railway. (Abstract.) H. Raynar Wilson (R R–March 30.) 1300 w.

30613. Locomotives of the Egyptian Railways. Ill. Clement F. Street (R R–March 30.) 500 w.

30614. Railroad Discipline. F. G. Darlington, with Editorial (R R–March 30.) 2500 w.

30615. The Handling of Private Cars. Editorial (R R–March 30.) 900 w.

30616. Railroads and Business Panics.—From the 26th Annual Report of the Massachusetts Railroad Commission (R R–March 30.) 1200 w.

*30622. Portable Railways for Works and Factories. (Abstract.) Ill. J. Walwyn White (E–March 22.) 4500 w.

30637. Railway Ships vs. Ship Railways. Editorial (R A–March 29.) 1100 w.

30638. Can Snow Blockades Be Avoided? J. W. Russell (R A–March 29.) 3000 w.

†30653. The Street Railway System of Boston. Ill. (S R J–April.) 18000 w.

†30656. The Quality of Street Railway Cables. Ill. R. J. McCarthy (S R J–April.) 2500 w.

30707. Portable Wood-Preserving Plant; Southern Pacific Railway. Ill. (E N–April 4.) 1600 w.

30708. Automatic Block System and Electro-Mechanical Slot; P. & R. R. R. Ill. (E N–April 4.) 1700 w.

30758. The New Shops of the Louisville, New Albany and Chicago Railway, at La Fayette. Ill. (R E M–April.) 1400 w.

30761. The St. Louis Union Passenger Station. Ill. (R G–April 5.) 1000 w.

30764. Oil for Locomotive Fuel in Southern California. Ill. George B. Leighton (R G–April 5.) 1500 w.

30765. Interlocking for an Electric Crossing.—Catlettsburg, Ky. Ill. (R G–April 5.) 600 w.

30766. The Right of the Electric Railroad in the Highway. Editorial (R G–April 5.) 2000 w.

*30773. Rolling Stock for 30 in. Gauge Railway in India. Ill. (E–March 29.) 1200 w.

*30774. French Railways and the State. Editorial (E–March 29.) 3800 w.

*30780. A Novel Idea for a Railway Surfaceman's Alarm. Ill. Charles R. Gibson (E L–March 29.) 1200 w.

*30790. On the Employment of the Electric Light for Railway Purposes. Ill. W. Langdon (E E L–March 29.) 9000 w.

30794. The Legal Aspects of Electrolysis. Henry C. Townsend, in Cassier's Magazine (S R G–April 6.) 5000 w.

30816. Duties and Responsibilities of a Railroad Bridge and Building Department (R R–April 6.) 3200 w.

30817. Feed Water, Circulating, and Blow-off Arrangements for Locomotives. Ill. (R R–April 6.) 1000 w.

30818. Protection of Grade Crossings of Steam and Electric Railways. Ill. (R R–April 6.) 1400 w.

30819. Terminals. W. A. Garrett (R R–April 6.) 3500 w.

30820. Competition of Electric Railways. Editorial (R A–April 5.) 1100 w.

30821. Passenger Train Service Between Washington and New York (R A–April 5.) 1800 w.

30822. Protection of Grade Crossings of Steam Railroads with Electric Railways. Ill. Charles Hansel (R A–April 5.) 1800 w.

30825. Pullman Car Trucks. Ill. Duane Doty. (R C J–April.) 1000 w.

†30827. The Railway to India. C. E. D. Black (C R–April.) 4000 w.

Serials.

17826. Evolution of the Air Brake. Ill. Paul Synnestvedt (R E M–Began Dec., 1893—14 parts to date—15 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M–Began Jan., 1894—12 parts to date—15 cts. each).

27603. A Treatise on the Construction of Railroad Rolling Stock. Ill. A. Flamanche, A. Huberti and A. Stevart (R C J–Began Jan. —4 parts to date—15 cts. each).

28138. Block Signaling. Ill. W. H. Elliott (L E–Began Jan.—4 parts to date—30 cts. each).

28304. Signals and Signaling. Ill. (R R–Began Jan. 5—8 parts to date—15 cts. each).

28496. Electric Traction. Ill. Philip Dawson (E–Began Jan. 4—12 parts to date—30 cts. each).

28897. Motor Repairs. Ill. (S R J–Began Feb.—3 parts to date—45 cts. each).

29144. Economy in Railway Operation. L. F. Loree (E Mag–Began April—2 parts to date —30 cts. each.)

29175. On Electric Cable Railways. Ill. C. S. Du Riche Preller (E–Began Feb. 1—4 parts to date—30 cts. each).

29369. Tramway Management. By a Manager (R W–Began Feb.—2 parts to date—30 cts. each).

29384. Street Railway Wheel Treads and Flanges.—Is a Standard Desirable? Ill. (S R R–Began Feb.—2 parts to date—30 cts. each).

29775. Yard Arrangements Along Heavy Traffic High-Speed Railroads. Ill. A. Flamanche (A E R J–Began March—2 parts to date—30 cts. each).

29881. Light Railways. J. Walwyn (I Eng–Began Feb. 2—2 parts to date—45 cts. each).

30158. Notes on Some French and Swiss Railways. Ill. (R W–Began March—1 part to date—30 cts).

30604. Locomotive Repair Shop Equipment. W. H. Weston (N C B–Began April—1 part to date—30 cts).

30654. Electric Railway Repair Shops. Ill. Henry P. Merriam (S R J–Began April—1 part to date—45 cts).

30668. The People's Highways. Frank Parsons (A–Began April—1 part to date—45 cts).

30787. Light Railways in Belgium. Anon. (Eng L–Began March 29.—1 part to date—30 cts).

SCIENTIFIC MISCELLANY

Scientific Illiteracy.

THE *Home Journal* (April 3) editorially criticises the too frequent illiteracy of contributors to the technical press. This charge has been made previously by other critics, and it may be well to consider it carefully. If it be true of those who have been trained in the leading technical schools, it certainly is not creditable to these institutions.

"Any one," says our contemporary, "having frequent occasion to examine the pages of the technical periodicals published in the United States cannot fail to be impressed with the fact that they are frequently written in English that should disgrace any graduate of an ordinary grammar school. It is difficult to account for this fact. Of course it is natural enough that among inventors and experimenters in applied science there should be a considerable proportion of men entirely without literary training. But, on the other hand, the technical schools and colleges supply the country yearly with hundreds and even thousands of young engineers who are supposed to have passed through a curriculum combining with science at least so much study of letters as is necessary to fit one for ordinary English composition. That from this vast body the scientific press should not be able to recruit staffs capable of maintaining its literary standard at a level with that of the average country daily newspaper is indeed phenomenal.

"The lack here deplored is not that of fine writing, or marked individuality of style, or studied rhetoric; these would be out of place in technical literature, which should be characterized by simplicity itself. Of technical writers there is no reason to demand greater literary power than that of constructing a grammatical, coherent, and intelligible sentence. But even this modest expectation is too often disappointed. The present writer has seen, not one, but many manuscripts written by professors occupying chairs in the scientific departments of colleges like Columbia, the meaning of parts of which it was almost impossible to ascertain, even when the subject was not difficult or the language technical. And yet nowhere is lucidity more to be desired than in scientific writing.

"To be sure, there are technical periodicals to which our complaint does not apply, but these are notable exceptions. One of these is the ENGINEERING MAGAZINE, whose original matter appears in clear and correct English. To its pages, however, one may turn for compact and accessible proof of the charge preferred. For it publishes each month an extensive review of the techinal press, much of which consists of quoted passages selected from technical periodicals for their scientific interest and value. So far as this review is rewritten, its English is correct and intelligible, but the quoted parts sometimes offer an extraordinary variety of involved and ill-constructed sentences. No blame for this attaches to the review itself, for it would be an enormous task to rewrite the whole, and an impropriety to take serious liberties with the matter enclosed in quotation marks. But the result is an astonishing revelation, especially as it is supposed to represent the better portion of the technical press. We wish that some of our technical contemporaries would endeavor to throw light upon the question why men of technical training should so often prove bunglers with the pen."

Now, the fact is that many of those who contribute to technical literature are men more or less advanced in life, who were in active service before the era of technical schools began.

Their education has not been systematic. A varied and wide experience has been the principal school of whose advantages they could avail themselves. Many of them are conspicuous for genius and ability. They have learned much, have much that is extremely valuable to communicate, and it has been well for the world that their consciousness of some lack of literary training has not kept them out of print.

Their lack of literary skill would be far less conspicuous, were their manuscripts more carefully edited. Want of care in revising "copy" is apparent in many of the very best of our technical publications. But, after all, it is not so much the manner of presentation as the matter that renders valuable the writings of this class of men. Contrary to the opinion of our contemporary, we think it would be desirable (were it possible) in all cases to couple with sound technical doctrine the graces of style; but an over-seasoning of the latter in technical writing, like a trick practised in cookery, has too often cloaked the lack of nourishing meat. It is, nevertheless, desirable that grammatical usage should be followed, and it is essential that sentences should be so constructed that their meaning shall be neither obscure nor ambiguous. If to these requisites the graces of rhetoric supply an added charm, —as, for a conspicuous example, in the scientific writings of the late Professor Tyndall, — they render the composition more acceptable to all cultivated readers; but this cannot be expected from the majority of technical writers.

But what shall be said of the lapses in style, grammatical form, and involved construction of sentences found in much of the literary work of college graduates and graduates of technical schools? This has not the excuse which may be offered for the work of graduates from the school of experience, and whose opportunities for acquiring skill in writing have been very meager. Is it not true that, as a rule, ample instruction and practice in English composition are not given either in colleges or technical schools? We believe the answer must be that this defect in our system of education is general. Of course there are exceptions.

A good style in English technical composition consists in the use of pure English and clear expression of ideas. It does not, however, necessarily imply that the charm of elegant rhetoric is to be deprecated in such writing, or that pleasing imagery cannot be used in illustrating a point. If the works of Tyndall were robbed of the beautiful style of that eminent writer, they might still retain their scientific value, but they would lose much for which they have commanded just admiration. But it is much better not to attempt such flights unless the imagination has learned to use its wings judiciously. In the palmy days of Union College, when Dr. Nott was president of that institution, it turned out some good public speakers and graceful writers. It is related that Dr. Nott, after having read a curiously involved sentence of thirty or forty words in a composition by one of the students, describing a peculiar effect of a blow upon the head,—the paragraph referring to what the patient did after receiving the blow,—was able to interpret the meaning to be that "he [the patient] went up-stairs and lay down."

"Is that not what you mean to have the reader understand, Mr. Blank?" asked Dr. Nott.

"Yes," replied Blank.

"Then why not say that, Mr. Blank?" and crossing out the clumsy effort at high style, the genial instructor penciled the seven words on the margin of the paper.

If many aspirants for literary fame would ask themselves first, "What is it I mean to say?" and, after having determined this point, would repeat Dr. Nott's query, "Then why not say that?" they would by such self-discipline acquire the art of writing simple, pure, strong English; and, as a help to fame and fortune, in an English-speaking land, this art is second to no other accomplishment that a professional engineer can possess. The ability to prepare a paper not only rich in valuable facts, but written in a happy, easy style, at once attracts the attention of his compeers, and brings him into prominence. In presenting to the public any scheme of improvement, or any engineering work with which he wishes to be identified, this talent enables him to impress its merits upon the minds of those he desires to enlist in the enterprise with a force that gives him immense advantage over a clumsy, slovenly writer. And all along the line of his work, in preparing specifications and reports, as well as in general correspondence, a good literary style will greatly enhance the effectiveness of what he desires to convey, thus strengthening his reputation and influence.

But, while admitting that the criticism of the *Home Journal* writer is justly applicable to the majority of technical writers, and that this fault indicates a defect in the schools from which they graduate, there are many notable exceptions whose writings are always clothed in a graceful, agreeable style. Naming off-hand a few of these, we shall necessarily omit many equally good.

Among civil engineers W. H. Caniff, Charles B. Going, and Benjamin Reece are at once recalled. Among sanitary engineers the names of Col. George E. Waring, Charles F. Wingate, and W. Paul Gerhart occur to us. Of mechanical engineers the first names of good writers remembered are Coleman Sellers, A. E, Outerbridge, Jr., and Dr. Charles E. Emery. Upon subjects relating to mining and metallurgy Professor R. W. Raymond and William L. Austin may be classed among the best writers in the country. Among the best writers on Architectures may be named Mr. E. C. Gardner and Mr. John Beverley Robinson. Among the numerous writers upon electrical subjects we readily recall the names of Elihu Thompson, Thomas D. Lockwood, Herbert Laws Webb and Albert A. Hopkins. Acceptable writers in the faculties of the technical schools include Professors R. H. Thurston and C. W. MacCord. Col. H. G. Prout, editor of *The Railroad Gazette*, Thomas Commerford Martin, editor of the *Electrical Engineer*, and Fred. Miller, editor of *American Machinist*, might well be three names with which to head a list of editorial writers upon technical subjects. If we made an effort to complete a list of good writers in all lines of engineering industry, we should require much more space than is at our command. A much larger list could be made of those whose "copy" would merit the criticism our contemporary has inclusively bestowed upon technical writing. We hope its attempt to call public attention to the illiteracy of technical writers may result in improvement; but, until greater attention to English composition is given in the technical and high schools, such improvement cannot be confidently expected.

Fire-Brick Clays.

THE refractory clays, commonly known as "fire-brick clays," of which large deposits are found near Perth Amboy, New Jersey, are made the subject of an instructive article by Mr. Charles Terry in *The Iron Age* (Feb. 4). In the first place the geological character of these deposits —"pure sedimentary clays"—is noted, and then their chemical composition is treated, these clays being refractory on account of their freedom from "accidental fluxing impurities,—namely, lime, magnesia, iron, and the alkalies,"—of which they do not contain in the aggregate more than 1 per cent.

"The beds afford every variety of pure clay, from those highest in alumina to the most siliceous clays, including the extra sandy, fire sand, and pure white quartz sand. Such an assortment of refractory resources is plainly an ideal basis to work from in making fire-brick mixtures, but a proper classification and application of them can only be reached by scientific means. With such a source of supply the fire-brick manufacturer derives great benefit from studying the conditions which exist in places where his fire-brick are to be used. It is impossible to make one grade of brick which will meet the requirements of the various classes of work equally well. The chemical composition and physical structure of fire-brick should differ as radically as the nature of the conditions which they must encounter. There are reasons why a high silica brick should give better results in certain places than one high in alumina; while, conversely, there are times when a high alumina fire-brick is more desirable than a pure silica fire-brick. Lime, magnesia, and the alkalies, forming fusible silicates with the silica of fire-clay, are usually eliminated to the greatest possible extent, though, in places where the heat is moderate in intensity and the brick are obliged to endure a great deal of severe abrasion, a small percentage of these accidental impurities works to advantage, in so far as it tends to toughen and harden the fire-brick when burned. It is a very simple and comparatively inexpensive matter to add a limited quantity of such substances to the mixtures in the process of manufacture; but to extract them from an impure clay is not only very difficult, but thoroughly impracticable. As a rule, the New Jersey fire-clays carry exceedingly small percentages of these impurities, if any, and are in perfect condition, chemically, for use. The deposits of New Jersey consist entirely of sedimentary, plastic fire-clays in a thoroughly disintegrated state. From an economical standpoint their conditions in this respect could not be improved."

The eye alone can not determine the quality of fire-brick. To the inexperienced eye, at least, they all look very much alike. Only a chemical analysis can determine their value in advance of their actual use. Fire-brick for different purposes must have different composition, "and the manufacturer must know how to adapt these various kinds of refractory material so as to insure the best scientific and practical result. If you should go to an iron manufacturer who is engaged in the production of pig, puddled, merchant, or cast iron, and ask him to tell in a general way the important characteristics of a superior fire-brick, his answer would probably be substantially as follows: 'One which burns (or fuses) very slowly, evenly, and without any tendency to waste away as a result of chipping off when subject to sudden changes of temperature.'"

As an illustration of the effect of mixtures, the mixture may be modified so as to reduce its fusibility, "though, if this is carried beyond a certain point, the ability of the brick to expand and contract suddenly is seriously impaired. Such a procedure is worse than robbing Peter to pay Paul, for in this case Peter's loss much exceeds Paul's gain." In conclusion, it is asserted that, if "a New Jersey fire-brick maker does not vindicate a supremacy in his pursuit by showing an ability to supply a highly superior fire-brick for any purpose, it is only because he has not properly formulated his brick mixtures."

The Bicycle in Health and in Disease.

THE use of the bicycle has become so common with both sexes that the opinion of an eminent medical authority—Græme M. Hammond, M. D., of New York, professor of diseases of the mind and nervous system in New York Post Graduate Medical School—upon its use as related to health will interest many readers. His exhaustive paper on this question, recently read before the New York Academy of Medicine, will doubtless be widely quoted in future discussions upon the advisability of bicycle exercise for persons in degrees of health varying from debility to full vigor.

The facts given in the paper are derived from physiological examination of subjects who have used the bicycle to a greater or less extent. Dr. Hammond asserts that he has found bicycle exercise a valuable therapeutic agent in the treatment of certain nervous diseases. As to its proper and reasonable use, he finds, from actual examination of subjects by methods and instruments which modern science has supplied, that healthy growth of the heart and increase of cardiac power results from bicycle exercise, and that the "breathing capacity of bicycle riders is largely in excess of that of the average man." These are conditions favorable to the continuance of robust health. "The muscular system of the bicycle rider is, as a rule, uniformly well developed. It is often claimed by those who are not properly informed that the exercise develops the muscles of the legs at the expense of the rest of the body. This is not so. On the contrary, the muscles of the back, chest, arms, and abdomen are employed a great deal—not to the same extent as the muscles of the legs, but sufficiently so to consider bicycle riding an exercise inducing general development of the muscular system. A great deal has been said in regard to the pernicious effects of riding with the body almost, if not quite, at a right angle with the legs. A peculiar malformation of the spine has been reported to result from this posture, and it certainly seems as if the lungs, and consequently the heart, must be greatly hampered in performing their work. To obtain some information on this subject I have carefully examined fourteen professional riders, seven of whom are the most celebrated racing-men in the world,—men who have obtained national reputations as great riders, who have ridden more races than any other men, and who always ride with the body at right angles to the legs. In no case was there any deformity of the spinal column, and I may say here, if any such condition has ever been observed, the number of cases of it must be very few indeed. I have never seen a case of it." The riders examined "were all well-built and muscular men, but . . . there was excessive development of the muscles of the thighs."

Excessive work on the wheel is pronounced to be "unquestionably injurious. Riding great distances at rapid speed is an abuse of the wheel which cannot be too severely condemned. . . . Moderate exercise, properly performed, invigorates the system, strengthens the muscles, and increases the powers of physical endurance, but excessive and exhaustive exercise does none of these things; on the contrary, it is decidedly injurious to health, and should never be encouraged. The position of the saddle should in all cases be such that the weight of the body is supported on the gluteal muscles, and not on the perineum; otherwise diseases of pelvic organs may result both with males and females."

Textile Schools in Massachusetts.

A MOVEMENT for the establishment of schools for imparting expert instruction in the manufacture of textiles is on foot in Massachusetts, and bills introduced in the legislature providing for the founding of such schools are now under consideration by the legislative committee on education. *The Boston Journal of Commerce* (March 16) gives an account of a hearing of arguments in favor of such schools by this committee. Many prominent citizens and some public men addressed the committee on this occasion. The diminution of skill and knowledge among New England millers was generally admitted by these speakers, and by some was lamented as the cause of the loss of prestige in textile manufacturing industries which has marked the history of this section since 1865.

On the Wednesday following this hearing, another audience was given to a number of Lowell citizens, who, in the main, expressed similar views. Ex-Senator Lawton said that it is the intention to make this school distinctly American. "The question is not," said Mr. Lawton, "one of education, but rather one intended to advance the labor interests of our State and industries. It is the purpose to give all who have started on a business career in this particular line an opportunity to extend their knowledge. It is the desire of the gentlemen to have a school which, for the present, will be open only evenings, and will be attended by those now employed in the mills. Lowell is particularly well adapted for such a school, being, generally speaking, the largest and oldest textile city in the State."

"James T. Smith, secretary of the Lowell Board of Trade, said that the idea of establishing a textile school originated with the citizens of Lowell, who had come to the conclusion that it might solve the problem of competition. A. G. Cumnock, agent of the Boot cotton mills, said that he appeared before the committee as a manufacturer, feeling the necessity of such a school. It is assured, said Mr. Cumnock, that a full set of machinery can be secured without cost, and all that is needed now is a cheap building, some power, and a good instructor. As to the advantages of Lowell, Mr. Cumnock said that there the largest carpet-mill in the world is operated; also one of the largest woolen-mills in the country. It also has the largest machine-shop in the commonwealth, and one of the largest knitting establishments in the country. He advocated opening the textile project with an evening school which shall not be a class one. He didn't want it to be understood that it was to be a rich man's school. Begin at the bottom. He then exhibited, to the interest of all, some samples of the industries of Lowell, and proceeded in an enthusiastic way until Chairman Roe said: 'That means good-bye to the Lowell School of Design' (connected with the Boston technological school)."

The Saxony Tanning School.

THE only school of its kind in the world, a school of tanning, is stated by the *Scientific American Supplement* to have been established in Freiberg, Saxony. From a report of the United States consul at Chemnitz, the following facts relating to this unique school are gathered. "The school was opened in 1889, and its object is stated in its name. In it instruction is given in practical and theoretical preparation of leather in tanning and in finishing. It is supported by the State, which devoted to it the sum of 5000 marks in 1893; by the city of Freiberg, which contributed 1500 marks; and by friends, who gave it 2385 marks. Besides money, presents of hides, rare pieces of leather, barks, nuts, etc., are sent to it, and also magazines and technical papers. Its scholars come from all parts of the world. Every year—since 1889—students from Prussia, Austria, Roumania, France, Meiningen, Russia, Holland, Switzerland, Bavaria, Oldenburg, and Saxony have been in attendance. For practical work the school is fitted up from cellar to garret with all kinds of machinery, from the steam engine, furnishing power, to the finishing machine that turns out the finest patent or calf leather. There are rooms and machines for the unworked skins, lime-baths, vats, and cutting, rolling, pebbling, stretching, and pressing machines. It is stated that all the machinery used was made in the United States, and the director of the institution worked for ten years in the tanneries of that country. The students devote most of their time to studying tanning, preparing, and finishing leather. They learn about oxygen, alkalies, carbo-hydrates, albuminoids, and fermentation. They study text-books and hear lectures. In addition they work in the tannery and the laboratory."

Dr. Schnoeder is the head of the corps of chemists and teachers. "Under these again is a regular corps of practical tanners, who take a hide, as it leaves the animal, through lime-baths to the polishing rolls and processes, watched at every stage by the students. To this work the students give at least ten hours a week,—two hours daily. Hides from all parts of the world are experimented on annually, and with all kinds of tanning, barks, and materials." The old processes are compared with the new. "The former give good, and the latter quick results; the former are expensive, the latter cheap." All the various materials in use for tanning are made the subject of both practical and scientific study. The different processes and their theory and practical effects are all studied in a thorough manner.

THE Chemical Society has conferred its Faraday medal upon Lord Rayleigh in recognition of the investigation which led to the discovery of Argon. Dumas, Cannizzaro, Wurtz, Helmholtz, and Mendeléeff were the previous recipients.—*Science.*

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*29955. Meaning of the Recent United States Patent Decision. Park Benjamin (E Mag—May.) 3000 w.

†30070. Further Experiments for Determining the Fusibility of Fire Clays. Ill. H. O. Hoffman (Tr A M E—March.) 3000 w.

30084. The Tanning School of Saxony (Sc A S—March 16.) 700 w.

30085. The Influence of the Bicycle in Health and in Disease. Graeme M. Hammond. From the Medical Record (Sc A S—March 16.) 4500 w.

30088. The Glasgow and West of Scotland Technical College. Ill. Andrew Pinkerton (E W—March 16) 1500 w.

30110. Transverse Strength of Douglas Fir. Ill. Charles B. Wing (E N—March 14.) 900 w.

30113. Wind Pressures in Engineering Construction. W. H. Bixby (E N—March 14.) 20000 w.

*30202. The Worthlessness of Petroleum

Inquiries. Extract from T. Graham Young (C T J–March 9) 2500 w.

†30265. Improved Methods of Water Analysis. Ill. Irving A. Bachman (J A C S–April.) 1500 w.

*30352. The Composition of the Extinctive Atmospheres Produced by Flames. Frank Clowes (C G–March 15.) 1300 w.

30389. Textile Schools in this State. Editorial (B J C–March 16.) 900 w.

30405.—75 cts. Some Experiences in Engineering Practice. Ill. George Duncan (T Q–Oct., 1894.) 8400 w.

30407.—75 cts. Some Observations on the Growth of Diatoms in Surface Waters. George C. Whipple (T Q–Oct., 1894.) 4800 w.

*30414. The Transport of Frozen Meat. Anon. (Tr–March 15.) 2500 w.

30442. The Dead Liquor in Ammonia Systems. H. C. Price, with Editorial (S E–March.) 1500 w.

*30444. The Modern Theory of Representation. Lewis R. Harley (A M C–April.) 3700 w.

*30446. Patriotism. Wilmot H. Goodale (A M C–April.) 4500 w.

*30447. An Historic Legislative Crisis. Alfred E. Lee (A M C–April.) 3400 w.

*30448. Colonial Relationship to the Mother-Land. J. H. Long (A M C–April.) 2700 w.

*30449. Revision of Constitutions. William W. Phelps (A M C–April.) 1500 w.

*30450. What True Patriotism Demands of the American Citizen. Roger Sherman (A M C–April.) 2200 w.

*30451. Reform from the Farmer's Point of View. Wilbur Aldrich (A M C–April.) 3000 w.

*30454. Some Aspects of the Liquor Problem. Henry O. Ward (A M C–April.) 2000 w.

30467. The Manufacture of Porcelain. Ill. of Knowles, Taylor and Knowles Co. (Sc A–March 30.) 1100 w.

30469. Cause of the Gulf Stream and Similar Ocean Currents. John P. Whipple (Sc A–March 30.) 1200 w.

30472. Fossil Land Surfaces of the Silurian. W. R. MacDermott (Sc A S–March 30.) 1700 w.

30481. One of New York's Old Landmarks. Castle Garden. Editorial (Am S–March 28.) 450 w.

30526. The Cliff Dwellings of the Lower Verde Valley, Northern Arizona. Sharlot M. Hall (Arch–April.) 1800 w.

†30547. Niagara and the Great Lakes. Ill. Frank Bursley Taylor (A J S–April.) 6800 w.

†30567. The Stratigraphy of Northwestern Louisiana. Ill. T. Wayland Vaughan (A G–April.) 8000 w.

†30568. The Paleontologic Base of the Taconic or Lower Cambrian. N. H. Winchell (A G–April.) 1800 w.

†30569. The Missouri Lead and Zinc Deposits. James D. Robertson (A G–April.) 5000 w.

†30570. On the Wind and Sand Dikes of the White River Miocene. E. C. Case (A G–April.) 2300 w.

*30578. The Flash-Point of Burning Oils: Is It At Present Consistent with Safety? Editorial (Inv–March 16.) 2500 w.

*30585. Modelling and Carving. W. N. B. (I C B–March 22.) 1200 w.

†30639. On the Atomic Weight of Oxygen. Synthesis of Weighted Quantities of Water from Weighted Quantities of Hydrogen and of Oxygen. Edward W. Morley (A C J–April.) 2200 w.

30688. Some Remarks on "Argon." Bohuslav Brauner (Sc A S–April 6.) 1000 w.

30690. The South Pole and Its Problems. F. A. Cook (Sc A S–April 6.) 2800 w.

30691. The Cause of the Movement of Glaciers. P. L. Addison (Sc A S–April 6.) 2800 w.

*30702. Engineers of To-day—and Yesterday. James Riley. Ill. (E Rev–Feb. 20.) 1600 w.

*30705. Engineers of To-day and Yesterday. Benjamin Alfred Dobson (E Rev–March 20.) 1200 w.

30757. The Liquefaction of Gases. Charles Olszewski (E M J–April 6.) 4800 w.

†30829. Points on Tires from the Repair-shop. John Lurie (I R W–April 6.) 2000 w.

†30830. Temperature vs. Pressure During Vulcanization. A. B. Hohmann (I R W–April 10.) 900 w.

†30831. Extraction of Rubber from the Minor Plants.—An Experiment by Mr. John H. Cheever (I R W–April 10.) 1000 w.

Serials.

24462. Graphic Statics. W. W. F. Pullen (P Eng–Began Aug. 10—15 parts to date—30 cts. each).

26996. Statically Indeterminate Structures and the Principle of Least Work (E–Began Nov. 9, 1894—Ended March 15, 1895—6 parts —30 cts. each).

28427. An American Engineer's Observations in Europe. J. F. Flagg (E R–Began Jan. 12—3 parts to date—15 cts. each).

28838. The Contributions of Chemistry to the Methods of Preventing and Extinguishing Conflagrations. Thomas H. Norton (J A C S–Began Feb.—2 parts to date—45 cts. each).

29531. A History of the Last Quarter-Century in the United States. Ill. E. Benjamin Andrews (Sc M–Began March—2 parts to date —30 cts. each).

30255. The Artesian Water-Bearing Area of New South Wales. Ill. E. F. Pittman (A M S–Began Feb. 2—2 parts to date—30 cts. each).

30382. Physical Work of Hermann von Helmholtz. A. W. Rücker (N–Began March 14—Ended March 21—2 parts—30 cts. each).

30386. Electrification of Air and Other Gases by Bubbling Through Water and Other Liquids. Ill. Lord Kelvin, Magnus MacLean and Alexander Galt (E R L–Began March 15—2 parts to date—30 cts. each).

COMMENT & CRITICISM

Gives It a Name.

[An esteemed correspondent, who desires to sign himself "Nemo" rather than use his own name in the present instance, assigning valid business reasons for this, has addressed to us the following letter.—EDITOR.]

SIR:—I went to New York on March 28 to meet an English friend just arrived from India. After the usual greetings, and after some conversation turning upon engineering progress in India, he produced a copy of *Indian Engineering* (Feb. 16), and, with a complimentary remark about the enterprise of colonial publishers and the marked ability of American writers upon engineering subjects, pointed out, as an example of both, an article signed Charles E. Emery, Ph. D., the name of an American engineer whose reputation is coextensive with the use of the steam engine throughout the civilized world.

Rather interested in the fact that Dr. Emery had become a contributor to a publication in far-away Calcutta, I glanced at the title, and, running my eye over the page, discovered, almost at once, that the article had been stolen—title, signature, and text in full—from THE ENGINEERING MAGAZINE for last January, being the first of two excellent papers in a mechanical series which had, as I have means of knowing, been purchased, paid for, and copyrighted by THE ENGINEERING MAGAZINE CO.

I handed the paper back to my friend with the remark that thieves on both sides of the globe are an enterprising lot, and that, for the most part, they are able to pick out the best quality of goods from the stock they are looting. I also asked him how he thought that other eminent engineer, Sir Robert Rawlinson, K. C. B., president of the honorable Institution of Civil Engineers, whose portrait is printed on the page opposite the title of Dr. Emery's article, would like to know that his picture was employed to embellish an assortment of stolen goods exposed for sale by the robbers that purloined them.

There cannot be the least doubt that the article was deliberately and with full intent stolen by the publishers of *Indian Engineering*, because this publication is included in the list of your regular exchanges,—page 696 of the same numb in which Dr. Emery's article appeared. The style in which the article is printed without any credit to THE ENGINEERING MAGAZINE, as well as the fact previously mentioned, indicates the intent to steal. A further indication is that it is marked (I), which shows also the intention to steal (II).

I can speak for myself, and feel sure I might speak for Dr. Emery and Sir Robert Rawlinson as well as every member of the numerous engineering societies and associations in both hemispheres, that such courses are not regarded honest in the profession. While the genus *thief* of the grand order *Robber* contains numerous varieties, it has been agreed by all moralists that its distinguishing trait is the habit of taking surreptitiously what belongs to others.

NEMO.

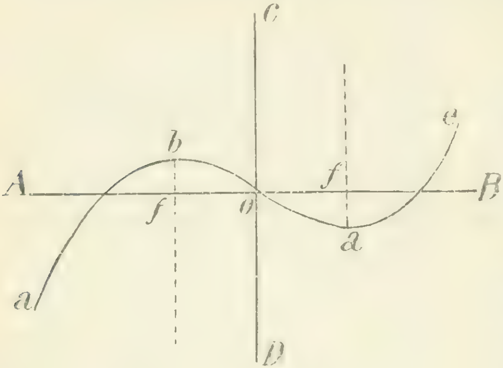
Boston, April 30, 1895.

Anchor Ice.

REFERRING to the review on page 115, current volume, I wish to remark that, while ice under certain conditions will float in water, it is equally true that under certain other conditions it will sink. While the floating presents nothing unaccountable, no intelligent explanation of the sinking of ice has been supplied.

To my mind this fact is really amazing. Year after year I have been tempted to tell the truth, the whole truth, about this matter, but it seemed so absurd to assume the instruction of an educated class of men upon a matter in their own line, and rather out of my line, that my natural modesty has restrained my pen.

The article on this subject in your April number sets forth many of the curious facts and phenomena of anchor ice, and the serious difficulties caused by it. I may also remark that much that Mr. T. C. Keefer is represented as saying should have been credited to Mr. Desmond Fitzgerald of Brookline, including the steam blow-out device for breaking up masses of ice at a gate-house.



It is both entertaining and instructive to examine such testimony, and much more could be presented. I shall not, however, attempt to assemble and analyze the various facts and theories relating to anchor ice which have come to my notice during several years, but will pass at once to an explanation and a remedy.

Ice contracts from 24° F,, up or down, and below 16° F. it will sink in water at 32° F. or at 48° F.; also below 8° F. ice will sink in water at 40° F. Most bodies in nature expand when heated, and contract when cooled. The volume of solids varies but little through difference in temperature; the volume of liquids varies more from the same cause.

There is a very singular fact connected with the expansion and contraction of substances at and near the temperature of fusion, which may be illustrated by the accompanying figure;

Let *A B* represent the abscissa axis of temperature, *C D* the ordinate axis of expansion or contraction, the origin *O* the temperature of fusion, *O A* the temperature of the solid, and *O B* that of the liquid.

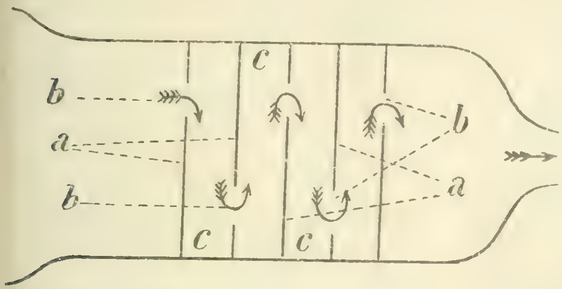
Let a solid of volume and temperature at *a* be heated; it will expand until it reaches a maximum volume at *b*, after which it contracts toward the temperature of fusion *o*. The temperature still increasing, the liquid will contract until it reaches a minimum volume or maximum density at *a*, after which it will expand toward *e*. The lines *a*, *b*, *o* and *o*, *a*, *e*, are parabolas, of which the axis of abcissas *A B* passes through the foci *f*. The formula for the parabola is $y = x^n$, in which the exponent n depends upon the nature of the substance, and also upon whether it is linear or volume expansion, x representing the temperature and y the volume.

Ice melts at 32° F., and the water reaches its maximum density at *a*, 40° F. Ice reaches a maximum volume at *b*, 24° F. Ice and water are of equal density at 16° F., 32° F., and 48° F. Ice generally floats in water because the difference in temperature is less than 16 degrees; but, as above stated, if ice of less then 16° is put in water at 32°, or 48°, or more, it will sink. The same phenomena is observed in other substances. For instance, solid cast-iron will float in molten cast-iron; but, if the fluid cast-iron be at a white heat, as in a pneumatic furnace, the solid cast-iron will sink.

From a consideration of these facts it is evident that, if a sufficiently cold wave descends upon an open body of water, the ice crystals will sink as they form. If the water be warm, the crystals will wholly remelt. If the water is at a 32° F. saturation, the results are serious. A movement of the air aggravates the case, since a necessary result is the more rapid removal of heat from the water.

The "anchoring" of the ice is due to the fact that, if a foreign solid body is introduced within a crystallizing medium, it disturbs the "balance," so to speak; and, as the operation can take place in but one direction, the solid body becomes the core or root from which the growth proceeds. Hence, if the bed or shore of a pond or river, or wood or iron work about a gate-house, are at a sufficiently low temperature, the ice attaches itself thereto, while the fact of their being at rest favors a rapid growth. Once anchored, it remains until destroyed by heat or violence.

The proper method of guarding a gate or other outlet is shown in Fig. 2, in which *a a* are deflecting dams or jetties, *b b* ports therein, and *c c* pockets into which the ice is projected by the current, precisely as water and oil are separated from steam by the inertia of the moving particles. This arrangement, with Mr. Fitzgerald's steam pipe blow-out at the gate or turbine, will solve the difficulty.



FRANK S. MASON.

Malden, Mass., April 8, 1895.

Hydraulic Engineering,

In connection with your recent remarks on Indexes (January '95 issue) it may be of interest to you to know that I have here a Card Index of Hydraulic Engineering, which now contains over 8000 cards and includes both *book* and periodical literature.

Also a "Topical" Index of the subjects, without references in dictionary form, giving the *subjects* or headings in alphabetic order, with cross references, and an analysis of each important heading as under Canals, Rivers, Water Supply, etc. The latter now covers about 30 pages of typewritten foolscap, and is growing.

I am willing and anxious to make this index of general use, and would be glad to coöperate with anyone in any desirable way. It will give me pleasure also to show the index at any time or describe my work in this connection in detail.

GEORGE D. COLTON.

Collinsville, Conn., April, '95.

BOOKS RECEIVED.

Carl K. MacFadden, Associate Member American Institute Electrical Engineers; William D. Ray, Associate Member American Institute Electrical Engineers, Vice President Chicago Electrical Association.=The Practical Application of Dynamo Electric Machinery. (Second Edition.) Revised. Chicago: Date & Rubbles, 1894. [167 pp., 5⅞×4". Cloth, flexible, Price $1.00.]

Third Annual Report of the Railroad Commission of the State of Texas, for the Year 1894. Austin, Texas: Ben C. Jones & Co., State Printers, 1895. [282 pp., 6"×9", paper.]

Arthur Kitson.=A Scientific Solution of the Money Question. Arena Library Series. Boston: Arena Publishing Co., 1895. [418 pp., 7¼"×5¼". Cloth, price $1.25; paper, 50 cts.]

Summary Statement of the Imports and Exports of the United States for December, 1894. Corrected to Feb. 1, 1895. With comparative tables and general statistical information. Prepared in the Bureau of Statistics, Treasury Department, Washington, 1895. [pp. 583-673, 9"×11¾". Paper.]

Annual Report of the Chief of the Bureau of Statistics upon the Foreign Commerce of the United States for the year ending June 30, 1893. Washington: Government Printing Office, 1893. [158 pp., 8½"×11". Cloth.]

Imported Merchandise Entered for Consumption in the United States during the years 1890-93, with Rates and Amounts of Duty Collected. Prepared in the Bureau of Statistics, Treasury Department, for the Committee of Ways and Means of the House of Representatives. Washington: Government Printing Office, 1893. [163 pp., 9"×11".]

Austin T. Byrne, Ingeniero Civil.=Sistemas Modernos de Alcantarillado y Neutralizacion de las Materias Nocivas Y Excrementicias en las poblaciciones; con referencia especial à los sistemas más adecuados á las condiciones topográficas de la Ciudad de la Habana Y Metodos Modernos Para Pavimentar Calles con referencia especial á las condiciones de la citada ciudad de la Habana. Habana: La Propaganda Literaria, (Premiada en varias Exposiciones) Imprenta-Estereotipia-Galvanoplastia-Librería-Papelería. Zulueta 28, entre Virtudes y Animas, 1894. [72 pp., 6"×8½", with maps and folding plates.]

Interstate Commerce Commission.=Preliminary Report on the Income Account of Railways in the United States for the year ending June 30, 1894. Prepared by the Statistician to the Commission. Washington: Government Printing Office, 1894. [59 pp., 6"×9", paper.]

Statistical Abstract of the United States, 1889. 12th number. Finance, Coinage, Commerce, Immigration, Shipping, the Postal Service, Population, Railroads, Agriculture, &c. Prepared by the Bureau of Statistics under the direction of the Secretary of the Treasury. Washington: Government Printing Office, 1890. [314 pp., 5¾"×9", paper.]

For further books received see page 401.

NEW BOOKS OF THE MONTH

THE ELECTRICIANS' ELECTRICAL TRADES DIRECTORY and Handbook for 1895. London: The Electrician, 1895. [907-CXX pp., 9″×6″, cloth, Price, 8s., 10d.]

THE handbook division of this directory contains an almanac and calendars, with dates and events of interest to the electrical world; a summary of electrical events for 1894, including obituary notices; information relating to patents, designs, and trade-marks; a digest of the civil laws relating to electric lighting and electric traction; board of trade lighting regulations up to date; London county council by-laws relating to overhead-wires and regulations as to theatre lighting; electric light and power regulations by other local authorities; rules and regulations for the prevention of fire risks arising from electric lighting (British and foreign); electric supply companies' installation regulations; electric lighting and electric traction notices for 1895; provisional orders granted by the board of trade in 1894; companies registered and companies wound up in 1894; detail statistics of central electric-lighting stations, electric railways, and tramways in the United Kingdom; electric standards from the order in council respecting the imperial ohm, ampere, and volt; rules for dealing with cases of apparent death from electric shocks; colonial and foreign import duties; post-office regulations, etc., etc. With numerous useful tables. The pages numbered in Roman notation include biographical sketches of famous electricians.

TRANSACTIONS OF THE AMERICAN SOCIETY OF MECHANICAL Engineers. Volume XV, 1894. New York: Published by the Society from the Library Building, No. 12 West 31st St [1359 pp., 6″ × 10″.]

THIS volume, made up of selected papers read before the society, contains a vast amount of discussion upon mechanical engineering in all its various phases, which renders the book extremely desirable for public and private libraries. Many illustrations and plates are employed in elucidating the papers and discussions, and the most cursory examination of the contents is sufficient to show that no working society of engineering either in this country or abroad is doing more earnest and good work than The American Society of Mechanical Engineers.

THE TELEGRAPH. TRANSLATED FROM THE FRENCH OF A. L. Ternant, by R. Routledge, B.Sc., F.C.S. With 196 illustrations. London, Manchester; New York: George Routledge & Sons, Ltd., 1895. [289 pp., 5″ × 7″. Price $1.50.]

THE first part of this book describes, illustrates, and discusses the principle of optical, acoustic and pneumatic telegraphy. Probably few are aware to what an extent light, sound, and air have been employed in the transmission of signals to distant stations. This book will acquaint them with the history of these kinds of telegraphy and the present state of the art. The second part deals historically, practically, and scientifically with electrical telegraphy. An interesting feature of the book is the portraits of men who have distinguished themselves in land and sub-marine telegraphy. Some of the illustrations are not strictly technical, but serve to give to the common reader an idea of the various operations involved in the practice of the art. The translation appears to have been very well executed.

A TEXT-BOOK OF STATICS. BY WILLIAM BROOKS, M. A., LL. B., R. A. S., general editor of the Tutorial Series, Principal of University Correspondents College, and G. H. Bryan, M. A., Smith's Prizeman, Fellow of St. Peter's College, Cambridge New York: W. B. Clyde, 1895. [220 pp., 7″ × 4¾″. Price, 40c.]

AN elementary course of statics is here supplied, which excludes those facts of the science requiring a knowledge of trigonometry on the part of the student. An effort has been made to lessen the difficulties usually encountered by beginners, here foreseen by the authors, who are experienced instructors in statics and dynamics This purpose is accomplished by hints and explanations, which, without removing the necessity of mental effort, direct the pupil's mind unconsciously to himself toward the intellectual point of compass where lies the truth he seeks. One of the best features of the book is the profusion of examples to be worked out. The solving of such examples will impress the principles of statics upon the memory more than any other exercise. The examples are framed with a skill that can come only by experience in teaching.

A TEXT-BOOK OF DYNAMICS. BY WILLIAM BRIGGS, M. A., LL. B., F. R. A. S., General editor of the Tutorial Series, principal of University Correspondents' College; and G. H. Bryan M. A., Smith's Prizeman Fellow of St. Peter's College, Cambridge. New York: W. B. Clive, [illegible] [illegible] and XIV pp., 5″×6¾″, cloth. Price, 50c.]

WHAT has been said above of the treatise on statics by the same authors is equally applicable to this elementary course of dynamics. Here, however, avoidance of some use of trigonometrical notation was impossible, even in an elementary treatise. A chapter on trigonometry, however, supplies as much of this branch of mathematics as is needed for the purposes of the work. The subject of dynamics presents to beginners greater difficulties than statics. Experimental illustrations are frequently used to aid in the mastery of the intricacies of the laws of motion. The examples for practice show the same evidence of skill and experience in teaching as those in the works on statics.

ELEMENTS OF PHYSICS FOR USE IN SECONDARY Schools. By S. P. Meads, Oakland High School, Oakland, California. New York, Boston and Chicago: Burdette & Co., 1895. [288 pp., 5″×7″, cloth. Price, 72c.]

AS an introduction to experimental physics, Mr. Meads has here supplied a very good text-book. A notable feature is the selection of typical experiments illustrating each principle enunciated, with ample instructions for its successful performance, and these selections have been specially adapted to the average ability of the grade of pupils for which the book has been prepared.

EVOLUTION AND ETHICS, AND OTHER ESSAYS. By Thomas H. Huxley. New York: D. Appleton & Co., 1894. [334 pp., 5″×7″. Price $1 [illegible]]

THIS is the ninth volume which has been published under the heading of "Collected essays" written by Professor T. H. Huxley and published by D. Appleton & Co. All who are familiar with the writings of Professor Huxley will expect to find it a very readable book, and they will not be disappointed. The chapter on "Social Diseases and Worse Remedies" comprises Prof. Huxley's letters to the *Times* on Gen. Booth's scheme of the Salvation Army; and, while according to Mr. Booth pure motives, points out inherent dangers that exist in the organization, which requires of its officers as absolute obedience to Gen. Booth as Jesuits are compelled to render to their superiors. In the first chapter, entitled "Prolegomena," the author shows that the state of civilized nature is, in a sense, hostile to natural conditions, illustrating it by the cultivation of a garden in which weeds that would otherwise destroy the cultivated plants are eliminated. It is therefore logically concluded that the present tendency towards individualism is retrograde rather than in the line of progress.

THE ELEMENTARY PRINCIPLES OF MECHANICS. VOLUME I: Kinematics. Volume II: Statics. By A. J. DuBois, C.E., Ph. D., Professor of Civil Engineering in the Sheffield Scientific School of Yale University, Author of "Elements of Graphical Statics," "The Strains in Framed Structures," etc. First Edition. New York: John Wiley & Sons, 1894. Volume I. [231 pp., 5¾″ × 9″. Price $4.00.] Volume II. [illegible] pp., [illegible]. Price $[illegible]]

FIRST-RATE text-books in every particular for which exacting criticism can demand excellence. The definitions are clear and accurate. The methods and arrangement are admirable. Prepared by a thorough master of the subject, an accomplished scholar and an experienced instructor, all the difficulties of the subject are approached on the line of least resistance. The student, properly prepared in his mathematics, who studies either the subject of kinematics or statics from these volumes will find in them so much of the kind of help he needs as to render the assistance of a living teacher almost unnecessary.

BOOKS RECEIVED.

Irrigation in Utah. Published by direction of the Utah Irrigation Commission. [128 pp., 5¾×8¾″, paper.]

Wynkoop Kiersted, Member A. M. Soc. C. E.=Determination of the Proper Size of the Supply Main for the new Water Supply of Galveston, Texas. Reprinted from selected papers of Rensselaer Society of Engineers, January, 1894, Troy, New York: E. H. Lisk, 1894. [12 pp., 6″×9″, paper.]

Statistical Abstract of the United States, first number, 1878. Finance, Coinage, Commerce, Immigration, Shipping, the Postal Service, Populations, Railroads, Agriculture, Coal and Iron. Prepared by the Chief of the Bureau of Statistics, Treasury Department. Washington: Government Printing Office, 1879. [157 pp., 5¾″×9″, paper.]

Statistical Abstract of the United States, 1885. Seventh and eighth numbers. Finance, Coinage, Commerce, Immigration, Shipping, the Postal Service, Population, Railroads, Agriculture, &c. Prepared in the Bureau of Statistics under the direction of the Secretary of the Treasury. Washington: Government Printing Office, 1886. [205 pp., 5¾″×9″, paper.]

Statistical tables exhibiting the commerce of the United States with European countries, from 1790 to 1890. Prepared by the Chief of the Bureau of Statistics, Treasury Department. Washington: Government Printing Office, 1893. [460 pp., 5½″×9″, cloth.]

W. L. Derr, New York Railroad Club.=Notes on appliances and methods of clearing up railroad wrecks. Meeting of January 17, 1895. Also contains copy of the new constitution and by-laws, and a list of the members, published by the club. John A. Hill, Secretary, 256 Broadway, New York, 1895. [54 pp., 6″×9″, paper.]

Proceedings of the Fourth annual meeting of the American International Association of Railway Superintendents of Bridges and Buildings, held in Kansas City, Mo., Oct. 16, 17, and 18, 1894. Printed by the Republican Press Association, Concord, N. H., 1895. [104 pp., 6″×9″, paper.]

City of Cambridge, Park Department.=Annual Reports for the year 1894. Printed for the Department. [Octavo, 120 pp., cloth.]

Dr. A. Scheidel, E. M. California State Mining Bureau, J. J. Crawford, State Mineralogist.=Bulletin No. 5. San Francisco, October, 1894. The Cyanid Process, its Practical Application and Economical Results. Sacramento: A. J. Johnston, Supt. State Printing, 1894.

Third Report of the Bureau of Mines, 1893.=Printed by order of the Legislative Assembly of Ontario. Toronto: Werwick Bros. & Rutter, Printers, 1894. [8vo., 205 pp., flexible covers.]

W. G. Hopper, author of "English Pen Artists of the Day."=A Practical Handbook of Drawing for Modern Methods of Reproduction. Illustrated with drawings by several hands and with sketches by the author, showing comparative results obtained by the several methods of re-production now in use. London: Chapman & Hall, Ltd.; Philadelphia: J. B. Lippincott Co., 1894. [161 pp., 5½″×8½″, cloth, price $2.50.]

New York Railroad Club, L. R. Pomeroy.=Steel Axles. Being a paper read before the New York Railroad Club December 20, 1894. New York: Published by the Club, 256 Broadway. [Pamphlet, 31 pp., 6″×9″.]

W. Kiersted and Dr. T. M. Drown.=Reports on the New Water Supply for the City of Galveston, Texas, in 1892 and 1893 Kansas City, Mo.: Tew Lyle Printing Co., 1893. [Pamphlet, 19 pp., 6″×9″.]

The Cornell University, Rochester, 1894-95. Ithaca, N. Y.: University Press of Andrews & Church, 1895. [Flexible cover, 278 pp., 5″×7½″.]

James Bell, A. I. E. E.=The Telegraphists' Guide to the New Examinations in Technical Telegraphy. London: "Electricity," 1895. [101 pp., 7″×4¾″, flexible covers]

Charles H. Sanders, Ph. B.=Handbook of Practical Mechanics for Use in the Shop and Draughting. Containing tables, rules, and formulas, and solutions of practical problems by simple and quick methods. Hartford: Student Publishing Co., 1895. [116 pp., 6″×4″.]

G. S. Turpin, M. A. (Camb.), D. Sc. (London), Principal of the Technical School, Huddersfield.=Lessons in Organic Chemistry, Part I. Elementary. New York: MacMillan & Co., 1894. [140 pp., 4¾″×6¾″, cloth, price $0.75.]

Report of the Massachusetts State Board of Health upon a Metropolitan Water Supply. Boston: Wright & Potter, State Printers, 1895. [233 pp., 9″×5¾″, cloth.]

Wilfred J. Lineham, head of the engineering department at the Goldsmith's Company Institute, New Cross; late professor of engineering at the School of Science and Art and Technical College, Newcastle-on-Tyne, member of the Institute of Mechanical Engineers of the North-east Coast, Institute of Engineers and Ship Builders, Society of Arts, &c.=A Text-Book of Mechanical Engineering; Part I, Workshop Practice; Part II, Theory and Examples. London: Chapman and Hall, Limited, 1894. [772 pp., 8″×5″, cloth.]

Twenty-fifth Annual Report of the State Board of Health, Massachusetts. Boston: Wright & Potter Printing Co., State Printers, 1894. [812 pp., 9″×6″, paper.]

David L. Day, chief of division of mining statistics and technology, department of the interior, United States Geological Survey, J. W. Powell, director.=Mineral Resources of the United States, calendar year 1893. Washington: Government Printing Office, 1894. [810 pp., 6″×9″, cloth.]

Second Report of the Bureau of Mines, 1892. Printed by order of the legislative assembly of Ontario. Toronto: Warwick & Sons, 1893. [263 pp., 6″×9″, with an appendix, "The Mines Act of 1892," 35 pp., half calf.]

Edmund B. Kirby.=The Sampling and Measurement of Ore Bodies in Mine examinations. Read before the Colorado Scientific Society, Denver, December 3, 1894. [Pamphlet 25 pp., 9″×6″ and 1 folding plate.]

Annual Report of the City Engineer of the City of Omaha, December 31st, 1894. Omaha: Klopp & Bartlett Co., 1895. [51 pp., 9"×6", and 12 large folding plates, paper.]

Joseph Edwards.=Labor Annual, 1895. A Year-Book of Industrial Progress and Social Welfare. Second Edition, revised and enlarged. Manchester: Labor Press Society, Ltd. [234 pp., 7¼"×4¾", paper, price 1 shilling.]

Reginald Bold, past president of the Civil and Mechanical Engineers' Society, associate member of the Institution of Civil Engineers, and member of the London Chamber of Commerce. =Motive Powers and Their Practical Selection. New York. Longman, Green & Co. [227 pp., 7½"×8", cloth, price $2 25.]

Report of the City of Baltimore Topographic Survey to the Mayor and City Council of Baltimore, for the fiscal year ending December 31, 1894. Baltimore: William J. C. DuLemy, City Printer, 1895. [220 pp., 9"×5¾" and 8 large folding plates.]

Henry L. Call.=The Coming Revolution. Boston: Arena Publishing Co., 1895. [239 pp., 7½"×¾".]

Charles Day, Wh. Sc. of the National Boiler Insurance Co., Manchester.=Indicator diagrams and engine and boiler testing. Manchester: Technical Publishing Co, Ltd., 1895. [205 pp, 7"×4¾", cloth.]

George William Sutcliffe, Whitworth Scholar, member Institution Civil Engineers. = Steam Power and Mill Work. Principles of Modern Practice. London: Whittaker & Co., 1895; New York: McMillan & Co., 1895. [886 pp., 7¼"×5", cloth, $4.50]

Report of the Commissioner of Education for the year 1891-92. Washington: Government Printing Office, 1894. [1294 pp., 9"×5¾".]

William C. Stubbs, Ph. D., Director of Louisiana State Experimental Stations.=A Handbook of Louisiana, giving geographical and agricultural features, together with crops that can be grown, description of each parish, climate, health, education, fish and oysters, railroads, water courses, compiled and written by request for the State Immigration Association. New Orleans. Free on application to the State Immigration Association, 620 Common Street, New Orleans, La. [56 pp., 9"×5½", paper.]

I. McKim Chase, M. E.=Screw Propellers and Marine Propulsion. First Edition. New York: John Wiley & Co., 1895. [230 pp., 6"×9¼", cloth, price $3.00.]

Ernest McCullough, C. E., member of the Technical Society of the Pacific Coast.=Public Works. A Treatise on Subjects of Interest to Municipal Officers. First Edition. 1894. [54 pp., 9"×6", paper, price $.25. For sale by the author, 511 California Street, San Francisco, Calif.]

Henry Gannett, chief geographer of the Geological Survey and of the tenth and eleventh censuses. = The Building of a Nation. The Growth, Present Condition, and Resources of the United States, with a Forecast of the Future. Illustrated with maps, charts, and diagrams. New York: Henry T. Thomas Co., 1895. [252 pp., 5½"×8½", cloth.]

George Martin Huss, member Architectural League of New York.=Rational Building. Being a translation of the article, "Construction" in the Dictionnaire Raisonné de 'l Architecture Française of M. Eugéne-Emmanuel Viollet-le-Duc. New York and London: MacMillan & Co., 1895. [367 pp., 8¾"×6", cloth, price $3.00.]

George F. Swain, Ira C. Baker, J. B. Johnson, editors. = Engineering Education. Proceedings of the Second Annual Meeting of the Society for the Promotion of Engineering Education, held in Brooklyn, New York, August 20-22, 1894, in conjunction with the American Association for the Advancement of Science. Vol. 2. [292 pp., 8½"×6", cloth, Price $2.50, post paid. Copies may be obtained of J. B. Johnson, secretary of the Society for the Promotion of Engineering Education, Washington University, St. Louis.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

The Q. & C. Co., Chicago, Ill., U. S. A.= Catalogue, 26 pp, 9"×6". [Describes and illustrates railway specialties and special machinery, including a line of car doors adapted to different purposes, the Q. & C. shop saws, globe ventilators, die plates, Bryant metal saw, Q. & C. wrecking frog, Q. & C. cattle guard, standard cattle guard, McKee brake adjuster, etc.]

The Goulds Manufacturing Co., Seneca Falls, N. Y, U. S A.=Catalogue, 429 pp., 7"×7". [Describes and illustrates, with price lists, pumps and hydraulic machinery for every service, pump supplies, well tools, &c. A notable feature of the book is its classified arrangement, all the appliances of the same class being grouped together. The book is thoroughly indexed, and each group is named in a table of contents. Evidently a great deal of labor has been expended in preparing this exhaustive list. Cover, cloth, black and gold.]

J. B. Prescott & Son, Webster, Mass., U. S. A.=Catalogue, 32 pp., 6"×9". [Describes and illustrates the Morse patent steel and iron ties for bonding hollow and veneer walls, terra cotta work, face brick ashlar, etc]

The Central Press Brick Co., Cleveland, Ohio, U. S. A.=53 leaflets, 9"×5½", printed on one side only, and eyeleted and tied together with robin's-egg blue cover. [Describes and illustrates a line of brick mantels, with a view to giving an idea to the public of the possibilities that can be obtained from the artistic use of pressed brick. Many of the illustrations are printed in colors, and the entire collection of samples is extremely elegant. It is stated that the samples contained in these leaflets are only a few of the many styles manufactured by the company.]

Walburn Swenson Co., Chicago, Ill., U. S. A. =Catalogue, 48 pp., 9″×6″. [Describes and illustrates the ore-dressing machinery manufactured by this company, and also complete plants for concentration of low-grade ores. Also describes coal washing machinery. Four pages of testimonials are presented; also a table of specific gravities of minerals, metals, and alloys. An interesting description of a concentrating plant built for M. Guggenheim's Sons, New York, for their works in Mexico, is a feature of this catalogue.]

The Dececo Company, Boston, Mass., U. S. A.=(1) Catalogue, 11 pp., 9″×11¾″. [Describes and illustrates improved plumbing appliances, lavatory combinations, &c., with price lists.]

(2) Catalogue, 12 pp., 9″×11¾″. [Describes improved water closet combinations manufactured by this company, with other plumbing appliances.]

(3) Catalogue, 31 pp., 9″×11¾″. [Describes and illustrates a line of bath tubs and fixtures. The catalogues are also supplied with a neat file for binding.]

Fred Adee & Co., New York, U. S. A.= Catalogue, 122 pp., 6″×4″. [Describes an entire line of plumbing goods, and sanitary specialties manufactured by this firm, with price lists of the same.]

The Brewer Pottery Co., Tiffin, Ohio, U. S. A.=(1) Catalogue, 60 pp., 5½″×6½″ [Describes and illustrates a line of siphon closets, washouts, pedestals, combined hoppers and traps, plain and embossed urinals, embossed basins, plumbers' vitreous china, &c. Beautifully printed on coated paper, with pink and gold cover.]

(2) Leaflet, 12 pp., 3¼″×5″. [Answers the questions frequently asked by plumbers: 1. "What causes so much crazage in earthenware?" 2. "Why do so many horns break off?" 3. "Why do earthenware closets become foul?" 4. "What causes a closet to crumble?"]

Nicholson File Co., Providence, R. I., U. S. A., 1894.=Illustrations of files, rasps, and tools. 60 pp., 14″×11″. [Contains also a description of the Nicholson File Company and its founder, William Nicholson, with views of the factories and offices of the works, World's Fair exhibit at Chicago, general information, and price lists. An elegant publication, printed on white paper with green edges, and bound in dark blue and silver covers.]

Fraser & Chalmers Chicago Ill. U. S. A.= (1) Catalogue No. 19, 2d Edition, Code word "Aspillerar." The Pelton Water Wheel. 61 pp., 9″ × 6″. [Describes the Pelton system of power, with the various styles of Pelton water wheels with general information as to hydraulic pipe water measurement, water power hoists, water wheels for high heads, air compression by water power, the Riedler air compressors and pumps, hydraulic nozzles and giants, with numerous tables for hydraulic calculations, &c.]

(2) Publication No. 29, 3d edition, Code word "Aspiraron." Fraser & Chalmers Library. Pamphlet, 47 pp., 9″ × 6″. [Discusses losses in gold amalgamation, with notes on the concentration of gold and silver ores. Written by Walter McDermott and P. W. Duffield. Special edition for complimentary distribution.]

(3) Catalogue No. 32. No. 32—Second Edition. 30 pp., 9″ × 6″. Ore Sampling Machinery. [Describes and illustrates H. L. Bridgman's ore sampling machines and apparatus for mixing and dividing ore samples.]

Buffalo Forge Co., Buffalo, New York, U. S. A.=(1) Leaflet, 8 pp., 7″×6¼″. [Describes and illustrates the "Buffalo" blacksmiths' drills and blowers.] (2) Leaflet, 4 pp. [Describes and illustrates the "Buffalo" tire upsetter. The Buffalo Forge Co. states that at great expense it maintains an up-to-date list of the blacksmiths of America, which it believes to be the most complete ever compiled, and that it makes a practice of sending literature of the kind named to each person on this list several times each season.]

D'Amour & Littledale, New York, U. S. A.= Catalogue, 15 pp., 6″×3⅜″. [Describes and illustrates the different varieties of "Sensitive" drills manufactured by this house.]

The Holly Manufacturing Co., Lockport, New York, U. S. A.=Catalogue, 79 pp., 10¾″ ×14″. [Describes and illustrates a great variety of horizontal, vertical, compound, and triple expansion and water-power pumps. Most of the engravings are full-page illustrations. The catalogue is printed on coated paper of fine quality. Cover, mulberry and gold, producing a very striking and beautiful effect.]

The Anchor Post Co., New York, U. S. A.= Catalogue, 21 pp., 6½″×3½″. [Describes and illustrates various styles of anchored posts for fences. Cover gray-green, printed with olive-green, producing a very delicate and neat effect.]

The Mason Electric Co., Racine, Wis., U. S. A.=Leaflet, 8 pp., 6″×3″. [Describes and illustrates the construction and operation of the Tracy patent oil filter.]

Oneida Community, Limited, Kenwood, New York, U. S. A.=Catalogue, 62 pp., 6¾″×8¾″. [Containing description and price list of animal traps, American chains, and Oneida steel wire chains.]

The Foster Engineering Co., Newark, N. J., U. S. A.=Pamphlet, 44 pp., 4¾″×6¾″. [Describes and illustrates a variety of pressure regulators and reducing valves. The pamphlet is entitled, "Facts Worth Knowing about Pressure Regulators, Reducing Valves and Pump Governors." Very nicely printed. Cover, French gray and indigo blue.]

Portland Stone Ware Co., Winslow & Co., Proprietors, Boston, Mass., U. S. A.=Catalogue, 60 pp., 4″×8″. [Describes and illustrates a great variety of fire-brick tiles, terra cotta vases, flue linings, chimney tops, cross straps, stone ware, &c. Cover scarlet and silver.]

Packard Electric Co., Warren, Ohio, U. S. A. =Catalogue, 23 p. [The Packard Transformer. Various sizes up to 300 lights. Full description and directions.]

For additional catalogues see page 38 following Improved Machinery.

THE
ENGINEERING MAGAZINE
VOL. IX. JUNE, 1895. NO. 3.

MALIGNANT EFFECTS OF THE FREE-SILVER DELUSION.

By Edward Atkinson.

PROBABLY no class of persons in this country, without being subjected to absolute want, has suffered more for lack of customary occupation or employment since the panic of 1893 than that which comprises engineers, architects, draftsmen, and their assistants. The reason is very plain. One of the principal functions of this class of professional men is to lay out and conduct constructive work; to make provision for future need; to open the ways for an extension of the railway service; to plan and put up factories, industrial buildings, commercial warehouses, and the like,—to say nothing of dwelling-houses. The first effect even of a commercial crisis is to retard the progress of constructive enterprise. The most malignant effect of a purely financial crisis like that of 1893 is to almost stop constructive enterprise. The reason is clear. All branches of industry depend in great measure upon credit for their conduct, but all branches of constructive enterprise depend absolutely upon credit being granted to the future, not only in lending money, but in trusting that a demand for the service of such constructive work will arise.

It follows that the worst enemy of the engineer, the architect, and the draftsman is he who impairs the credit of the nation's unit of value. There is no class in the community more capable of measuring the malignant influence of the silver craze upon itself than this class, and there is no class of the community that would be more fully and surely justified in denouncing the advocates of the free coinage of silver.

There is one example which may be statistically measured. It is an example which has probably been least affected by the silver craze,

Copyright, 1895, by the Engineering Magazine Company.

and which perhaps, of all the branches of work named, gives the least employment to the engineer,—to wit, house-building. We may fairly compute the increase of population during the last two years of depression at exceeding three million persons. If we assign to each one of the three million a dwelling-place at a cost of $100, which would be at the rate of only $500 for a house or an apartment for a family of five persons, the expenditure for merely housing an additional three millions of people would amount to $300,000,000, and that would stand for the work of 500,000 lumbermen, brick-makers, lime-burners, wood-workers, carpenters, nail-makers, and the like, in addition to the work of many designers, architects, and draftsmen, at an average of $600 each. Taking this absolute need as a unit, and developing from that the increasing demand for work-shops, commercial warehouses, factories, and other buildings under normal conditions, one accustomed to dealing with such a subject may imagine the evil effect of retarding constructive enterprise or stopping adequate preparation for the future need of an increasing population, even for a short time. Another aspect of the case is that, in proportion as the constructive enterprise is stopped, the crowding of existing buildings is increased.

It is, of course, impossible to determine by figures what proportion of the working population of this country—mental, manual, and mechanical—is and must be engaged in constructive enterprise. From all the investigations which I have been able to make, I think that the proportion, under normal conditions, would be 10 per cent. of the whole number. It is approximately, if not exactly, true that 90 per cent. of the work of a great community is devoted to the immediate purpose of providing the means of living, while 10 per cent. may be devoted to the conversion of food, fuel, metal, and other materials into more or less permanent forms of capital for reproductive service. The end of all production is consumption. Consumption consists mainly in the mere support of life. The energy developed by way of consumption may, however, be in part, and in about the proportion of 10 per cent., devoted to the maintenance and increase of the capital of the nation. It is necessary to the orderly and normal conduct of business that both these processes of consumption should advance in due proportion and without serious interruption or retardation. It is a well established fact among business men that a difference of 5 per cent. in the production and consumption of the necessaries of life may have a much more than proportionate influence upon prices and occupations. A deficiency of 5 per cent. in any necessary article may advance prices in much greater measure. On the other hand, an excess of 5 per cent. forced upon the market may and often does depress prices in a vastly greater proportion than that. If, again, that excess is continuous, owing to a lack of consuming power, or to a reduction of the consuming power to a point below the normal, the influence becomes very malignant, and nearly all prices may for the time be forced below the cost of production,—the evil itself generating other evils of like kind in increasing proportion until the cause is removed.

Dealing with these general facts, then, let us review the recent period. Our population has ranged from sixty-eight to seventy million persons since the panic. Substantially one in three of the whole number is habitually occupied in gainful work,—mental, manual, or mechanical. The total number of workers of all kinds has therefore been about twenty-three million. If 10 per cent. of that twenty-three million should be, under normal conditions, occupied in constructive work, the total number in that class would be 2,300,000. Now suppose constructive work stopped only in the proportion of one-half. We should then have conditions under which more than one million persons would be wholly without work, and competing with all others for such work of that kind as might be found. Hence diminished consumption, production in excess of the demand, depression of prices, and discontent among the other 90 per cent., whose work is continuous, but may be performed at a loss for the time being, one class of course also competing with the other on the work which must be continuous.

Do not these theoretic conditions exactly correspond to the real conditions that have prevailed since 1893? The number of the absolutely unemployed has probably been greatly exaggerated. The number of those whose wages have been reduced has been exaggerated. Yet the privation has been very great, and the number of persons affected, even though a small proportion of the whole, has been very large. What caused the partial stoppage of constructive enterprise? Lack of credit. What caused the break in credit, the withdrawal of foreign capital, and the hesitation of the capitalists of this country to do anything with it? The silver craze,—nothing but the silver craze, and the danger that the unit of value of this country would be debased.

Who are the chief promoters of this fraud upon the community? There are admittedly a great many sincere and upright men who believe that a bimetallic system of coinage and of legal tender can be entered into by the great commercial nations of the world, under which agreement the two metals, coined in weights governed by a fixed ratio, can be kept at a parity. This class of advocates of the bimetallic or alternate legal-tender use of silver and gold are entitled to our respect, and are to be met by argument on the part of those who do not believe that under any agreement or treaty the value or intellectual estimation of silver can be kept equal to that of gold at a certain fixed ratio. It is not with these men that the present issue is raised. The representatives of mining camps in our national senate, who command immense sums of money, who lend their own money on mortgage on a gold basis, the banks of whose States maintain a larger proportion of their reserves in gold than do any other banks of this country, and by whom every other interest of the country is made subordinate to this petty silver industry, are the men who must be marked down for public discredit, and be deprived of their malignant power in the senate of the United States.

Provision for the dwelling-place has been considered ; we will now deal with the railway problem. Long before the panic of 1893 the speculative construction of competing railway lines and of parallel lines had come to its natural end, but the absolute necessity for the construction of railways in many parts of this country had not ceased. In fact, in many great sections it had hardly begun to be realized. For example, Texas covers an area substantially equal to that of West Virginia, Ohio, Illinois, Indiana, Wisconsin, and Iowa. These States already possess over 42,000 miles of railway. In Texas there are a little over 9,000 miles ; yet the resources of Texas yet to be developed are equal, if not superior, to those of the several States I have named. No State has suffered, or will suffer, more from the free coinage craze than Texas. The perversion of her public men on this fallacy has destroyed her individual and corporate credit and kept capital out of the State, and will continue to do so. No sane man could be expected to lend capital now in his possession upon a gold basis to the people of a State who were so insane as to believe that they could rightly pay him off in silver dollars possessing a bullion value of only half the capital lent. Hence it follows that there has been, and is, little or no occupation for the engineer, the draftsman, the architect, and the professional man in Texas compared to what there might and ought to be. The same rule applies with more or less force to every State in which the public men who may be assumed to represent the average ignorance or intelligence of the people are supporters of the free coinage of silver.

The pretexts upon which the free-silver fraud is based are numerous. We will take up two or three of the most prominent. First, the claim has been made that we must protect the silver industry : and by every possible method people have been deceived and misled as to the magnitude of this industry. In the census of 1890 there is a complete report of the facts of the silver industry. They are substantially as follows : it gave employment in the year for which the census was taken to a little force of about thirty three thousand men, earning average wages as compared to other classes in the community working under similarly arduous conditions. About half the number were engaged in the development of silver ores, from which about half the silver bullion product was derived. The other half was derived from copper and lead ores,—the silver to a certain extent, sometimes to the full extent, being a by-product, and in some cases costing nothing because the principal product paid a profit on its own production.

It is doubtless true that great improvements have been applied to the production of gold as well as of silver, assuring an absolute abundance of gold for any length of time which it is worth while to consider. All the predictions of Professor Seuss and other so-called authorities of the falling off in the gold product have been discredited by the fact of an abundant increase. It is, however, manifest that the applications of science and invention, and the discovery of mines and deposits of silver, have had a far greater effect upon the silver product than have any corresponding influences upon the gold product. In order to prove these statements, reference needs only to be made to the estimates of the world's production of gold and silver from 1870 to 1894 inclusive, given by the director of the mint.

Years.	Gold.	Silver.
1870	$106,850,000	$ 51,575,000
1871	107,000,000	61,050,000
1872	99,600,000	65,250,000
1873	96,200,000	81,800,000
1874	90,750,000	71,500,000
1875	97,500,000	80,500,000
1876	103,700,000	87,600,000
1877	114,000,000	81,000,000
1878	119,000,000	95,000,000
1879	109,000,000	96,000,000
1880	106,500,000	96,700,000
1881	103,000,000	102,000,000
1882	102,000,000	111,800,000
1883	95,400,000	115,300,000
1884	101,700,000	105,500,000
1885	108,400,000	118,500,000
1886	106,000,000	120,600,000
1887	105,775,000	124,281,000
1888	110,197,000	140,706,000
1889	123,489,000	155,428,000
1890	118,849,000	163,032,000
1891	130,650,000	177,352,000
1892	146,298,000	197,741,000
1893	157,228,000	209,165,000
1894......Approximate only	170,000,000	193,000,000*

It will be remarked that, in face of the depreciation in the value of silver relative to gold, the production of silver has gone on increasing with scarcely any let-up, proving that there has been no cessation in the profit of this work when conducted on modern scientific methods. It will be plainly seen that at the rate of progression indicated by these figures there could be no safety whatever on the part of any country in continuing to maintain silver as its standard of value. Acts of legal tender, treaties and agreements would be equally powerless in the face of these data of production.

---

* The estimate of silver for 1894 is based on figures taken from *The Financial Chronicle.*

After 1878, when the compulsory purchase of silver bullion by the government began, great improvements were made in mining and metallurgy, corresponding to those which have been made in all other arts. The cost of the production of silver was reduced, but the demand was artificially kept up by the compulsory purchases of the United States. Since those purchases stopped, many mines have come to a standstill, and there was for a time a lack of employment in the silver-producing States among a small number of persons,—a mere fraction as compared to those who have been injured and who have suffered lack of employment under the domination of the promoters of the silver delusion among the people. It is now well known that this force has found work either in gold mining or other industries. The market value of the silver produced is trifling as compared to the total product of this country, and, as I have often had occasion to say, is equal now only to one-third to one-half the value of the annual product of hens' eggs. The attempt to set this industry up as one to which the great interests of the country should be rendered subordinate proves to be absurd, the moment the glamour which surrounds the mining of the precious metals is dispersed and the silver bubble is pricked. Aside and wholly separate from this attempt of the promoters of the silver industry to raise the price of silver at the cost of the country, an opinion is held by many sincere, but deluded, persons that the prices of other commodities, consisting of the necessaries, comforts, and luxuries of life, have been unduly depressed by the so-called demonetization of silver. Silver has not been demonetized anywhere, and the monetary use of silver is now larger than it ever was before. It has simply been displaced from its function of a full legal tender. The opportunity to do this was offered by the increasing abundance of gold, which, proving more suitable as a unit of value, has forced its way into the position of the world's unit of value in all international commerce, without regard to statutes or acts of legal tender of any kind. The production of gold is now greater than the production of gold and silver together were in 1871-3, and it is rapidly increasing. Gold itself has lost a part of its purchasing power. This can be readily proved by reference either to average or to particular prices. If we deal with the average price of commodities on a gold standard developed from Sauerbeck's tables,—

the authority of which is accepted by both parties in this controversy,—we find that the index number of prices in 1892 was substantially the same as it was from 1845 to 1849. By comparison with 1860 there has been an average reduction in prices in some measure, but not fully corresponding to the general reduction in the cost of labor and in the charge for distribution. By cost of labor I do not mean rate of wages. In all arts to which science and invention are applied the reduction in the cost of labor is effected by the relative rise in the rate of wages and in the purchasing power of wages. If we deal with each specific article of necessity or comfort,—food, fuel, fibre, or fabric,—we find that there has been no uniformity in the course of prices on a gold basis. The prices of a few articles have risen since 1873, in which year the high prices of the speculative era culminated, such articles having become relatively scarce in ratio to the increasing demand. Others, notably animal products, have maintained a fairly substantial average at about the same ratio, subject to but little reduction. This, again, is due to the increased consuming power of the masses of the people, who have thriven greatly upon the gold standard. A few other articles, notably wheat, have fallen materially. If, however, each of these classes or each particular article is dealt with separately, two facts are disclosed. First, that during a period of 25 years antecedent to 1873, in which the relative value of silver to that of gold was fairly uniform, there were as frequent or more frequent commercial crises, as great fluctuation in prices, and, at one time, a fall in prices very nearly to the present level, in the face of an increasing production of both gold and silver. The so-called bimetallic system had apparently little or no influence in maintaining uniform conditions in respect to prices and wages. Since 1873 the tendency has been to a reduction in prices corresponding in some measure, but not fully, to the reduced cost of production and distribution.

This phase of the subject especially interests the readers of an engineering magazine, and I would venture to suggest a research which I have not the time to conduct to its conclusion on the special applications of science and invention to the different arts. I will only deal interrogatively with the main subjects of consumption. Is it not true that an intelligent farmer can either derive double product from a given area of good land by the employment of the same number of hands that he employed in 1860, or derive an equal product from the same land at less than half the cost of labor and capital required at that date? In reply to this question the whole art of the engineer and inventor, as applied to agricultural implements, tools, and machinery, should be explored, and the influence of each invention on the cost of labor measured.

In metallurgy—notably in iron, and perhaps as much in copper—is it not true that double to treble as much can be produced to-day as in 1860, at one-third to one-half the cost, by the employment of the same quantity of labor, or even less, in any well-established mine, furnace, or works? Has not this improvement been accompanied by higher wages, the correlative of lessening cost of production?

A history of these and all other arts would develop the fact that any attempt to connect the price of silver with the change in the prices of food and metals other than silver would simply be an absurdity.

In dealing with wood-working, from the timber to the completed fabric; in dealing with the milling of grain; in dealing with the making of paper,—have not complete revolutions been brought about by science and invention, doubling the product per unit of labor, or trebling it; saving that which had been wasted; increasing the abundance; lessening the price; raising the wages; and, while diminishing the margin of profit, leaving great aggregate profits to the benefit of those who conduct the work? In fact, let any intelligent person take up every branch of the production of food, textiles, metals, and the like; while he will find that the influence of reductions in taxation has been considerable,—especially that effected by the removal of duties on the import of materials necessary to the processes of our domestic industry,—he may be challenged to name a single product of any considerable moment of which the supply and demand or the price have been influenced in any permanent or considerable measure by the variations in the ratio of the value of silver bullion to gold bullion. There have been temporary disturbances in the conduct of commerce between the gold-standard States and the silver-standard States, but, unless the absurd position is taken that a depreciation of the currency is a benefit to the country which is subjected to it, it will be impossible for the advocates of the free coinage of silver to prove that there has been any benefit from the depreciation of silver to any of the silver-using States,—India, China, or any other country. On the contrary, they have been subjected to many hardships which the advocates of the free coinage of silver are now attempting to bring upon our own country for their own selfish purposes of private greed and private gain.

The end of the question has really come. The solid sense of the country has been aroused, and under the bold and conclusive leadership of the president and his cabinet the question has been finally settled. The renewal of activity and energy can be witnessed throughout the country. Before the next congress assembles the favorable conditions of the country will forbid any further malignant influence on the part of the so-called silver States and their mis-representatives in the senate and house.

THE GROWTH OF AMERICAN EXPORT TRADE.

By T. A. Eddy and Carl Schurz.

Mr. Thomas A. Eddy, of the great New York exporting firm, Flint, Eddy & Co., sailed on May 4 for Europe, and thence to South America, for a long business trip, and, just before embarking, he was interviewed by a reporter for the New York *Sun* in relation to the outlook for American export trade. His information is of such definite character, and what he has to say is of such manifest importance, that in the interest of American industry and enterprise we reproduce those portions of the interview of special concern to our constituency of readers.—THE EDITOR.

AMERICA will probably, in the near future, dominate all the markets of the world in the production of manufactured goods. The old-time supremacy of England is on the wane, and even in England itself many grades of American goods, particularly cotton goods, manufactured leather, and iron, are sold more cheaply than the native products. Indeed, the United States are going into the manufacturing export business at a rate which is causing grave apprehension to English and other European manufactures.

Whereas at one time almost the sole export business of the country was in food and agricultural products, to-day the export of manufactured goods is about one-third of the total export of the country, and is annually growing at a rate which to foreign competitors is alarming. The age-honored theory that the markets of the world could never belong to America so long as American wages continued to be the highest has proved a fallacy. The industry and superior genius of the American workingmen, more than make up the difference in the wages.

The United States have need of this increase in the amount of manufactures exported to maintain in our favor the annual balance of trade, for the reason that our exports of food and other raw products must inevitably decline. Thus the new Argentine competition with the United States in wheat may be expected to increase permanently, lessening our hold upon the world's grain markets. It is true that there has not yet been so great an increase in the total value of manufactured goods exported, but it is estimated that of late the average decline in the price of the goods included under this head has been not less than 15 per cent., indicating a considerable increase in volume, although on a lower basis of value.

In certain classes of tools and hardware Americans, owing to the greater use of machinery and larger output, have long stood preeminent. Australian and South African doors are furnished with American locks and knobs, and we furnish the doors themselves. An infinite variety of hardware used in the construction of dwellings is also shipped abroad in great quantities, and some people may be surprised to know that one of the very best markets we have is England.

Of the new articles of export, take barb-wire fence. Five years ago the cheaper labor of England, Germany, and Belgium made it impossible for American manufacturers to compete with those countries in supplying this article. In these five years the superior genius and industry of the American workmen have revolutionized the business of manufacturing wire in this country, and enabled us to supply the whole world with it. We have beaten England, Germany, and Belgium in their own markets. We have driven their own manufacturers out of the export business. Take the next article that I mentioned,—wire nails. For years German and Belgian manufacturers have defied competition. They have undersold the Englishmen and have controlled the English market, but have learned how to make wire nails. Our inventors have given us machinery superior to any possessed in either Germany or Belgium, and wire nails are now being shipped from the United States to every part of the world in ever-increasing quantities. I know of one order for 20,000 kegs of these nails, given by one of the great houses of Birmingham. We landed those nails in England cheaper than they could be made there and cheaper than they could be imported from continental countries.

Now look at the steel business. We are to-day exporting American steel rails to Cuba in competition with German and English manufacturers, and our manufacturers are extending their inquiries for business to South American countries. In this commodity tonnage is the principal question. The more we make, the cheaper we can make. The more we increase our output, the more dangerous competitors we become to England and Germany. It is only a matter of time when we shall control a large portion of the markets of the world in this line. American locomotives have been shipped to Brazil, to Argentina, and even to Australia. We manufacture them here and ship them to those countries and deliver them to the purchaser there set up on the rails in running order, at prices very much lower than the English or continental manufacturers can name. Armor-plate is another thing that we have begun to export. You know, of course, that this is now being supplied by one of the great American iron works to the Russian government, the order having been taken in competition with the most celebrated English and European makers.

We are particularly successful in the exportation of agricultural implements, such as harvesters, mowers, and headers. We are shipping these articles in great quantities to Russia and to South America, and our orders are constantly increasing. It is only necessary, in order to demonstrate the fact that our great competitors, the British, fully appreciate the competition which this country is now giving them, to quote from an article in the London *Times.* I don't remember the exact date, but I made a memorandum of the words :

> Speaking at a meeting of the council of the London chamber of commerce last week, Mr. Bindloss made rather startling reference to the diversion of the British iron and steel trade to other countries. Of late years the United States had developed their own resources, and had so stimulated production that they could not only supply themselves, but severely interfere with England in foreign markets ; and he would not be surprised if by and by they threatened competition even in this country.

The competition referred to by Mr. Bindloss has come to pass, as great quantities of American iron have been shipped to England itself, and contracts are made to-day by which American manufacturers undertake to lay down gas, steam, and water pipes in English warehouses at lower prices than the Englishmen can meet.

In the great gold and diamond mines of South Africa all of the iron pipe used is produced in America. Why, within a few weeks a single consignment of a train-load of twenty cars was shipped to Africa. Nearly all of the gold-mining machinery of the great mines of the Transvaal is made in Chicago, and not many months ago a steamer was loaded at New Orleans with machinery for Africa. It was shipped down the Mississippi river to that point. Take bar iron as another example ; that is the iron for blacksmiths' use. We are shipping that to Japan and China and other Eastern countries. A very recent shipment consisted of 450 tons. We are shipping cotton ties and hoop iron to Bombay and Calcutta.

Sulphate of copper is another article which is very largely exported to France and Italy, and small shipments have been made to South Africa. Not only is the American sulphate of copper much cheaper than the European or English product, but it is of infinitely better quality, and promises to control the markets of the world.

There was another article in the London *Times* recently which pointed out that the United States had practically overtaken the United Kingdom as a coal-producing country. Just take the figures a moment. In 1870 the United States produced only one-third as much coal as Great Britain ; at the end of the next eleven years—that is, in 1881—we find that the product had increased to one-half that of Great Britain. To-day the two countries have practically come abreast of each other, and the result has been that everywhere Great Britain has ceased to command the supremacy which she formerly enjoyed as the chief coal-producing country of the world. I think it will be a matter of surprise to some people to know that regular shipments of coal in cargoes are made to Liverpool for gas-making purposes. The United States produce the finest coal in the world for making gas. The Englishmen have learned that, and they purchase it in preference to their own product. The Spanish and English West Indies are supplied with coal from the United States as far down as Grenada,—one of the most southerly of the Windward group of islands in the West Indies. The mineral statistics show that the average value of the coal output of the United Kingdom in 1892 was 7 shillings and 3 pence, and in 1894, 6 shillings and 9 pence, per ton. In the United States the reported value of the output of bituminous coal for several years past has not averaged much over 4 shillings and 3 pence per ton, and in some States the average has been about 3 shillings and 6 pence. Hundreds of cargoes of coal are ordered from England at prices considerably in excess of those at which the same coal could be bought in the United States, the main reason being the fact that with free trade they are able to secure lower freights for coal-bearing shipping, because such vessels can obtain return cargoes.

I was very much struck by an article that was published lately by Hiram Maxim. In that article he referred to the skill of American mechanics as compared with the English, French, and German, and he awards the palm to the Americans as being more intelligent, more industrious, and much more productive ; furthermore, as possessing the inestimable advantage of not being so seriously hampered by trades unions as is the case in England. That article was true. The American workman is also much more inventive than the workmen of any other country. Why, go into a factory to-day and you will see something being done by hand, and you go in the factory next week and you will find that some workman in the factory has invented a machine to do the work. The machinery in American factories is largely the invention of the American workman, and the improvements on the original machine are of his invention. He will go to work at his machine, and in a day or a week he will think of something that will make that work just a bit easier, or that will make it possible to run his machine at a higher speed, and to get more out of it. He will set himself to thinking, and shortly he has got an improvement that maybe doubles his producing capacity.

It is true, too, that the American workman is not seriously hampered by trades unions, as is the case in England. I know it is generally understood that the relations between capital and labor in this country are strained. The newspapers talk about it, and the Socialists and Anarchists talk about it, and the dissatisfied of the population lecture on it, and try to drum it into the ears of their fellow-workmen, but the relations of the employer and employed here are infinitely better than they are in Great Britain. Why, here was a case not long ago in Fall River, where the manufacturers, without even a demand being made upon them, restored the rate of wages paid last August. They did this without anybody asking them to. If there had been any strained relations, it is not likely they would have done it.

England is actually cursed by trades unionism. A very good illustration of this fact is furnished by the shoe strike in England, where the prices to be paid to labor for shoe-making are established by trades unions. This strike was brought about by the desire of the English manufacturers to introduce improved American machinery in order to meet the American competition, and the workmen declined to use the new machinery and struck. You don't find the English workmen inventing machines to take the place of handwork. They not only won't invent them, but won't permit their use when they are invented. Before this strike began the American shoe trade had for some time been rapidly increasing in England. As with other manufactured articles, the commodity, once introduced, took a firm hold. By striking, the workmen there have given the American manufacturer a golden opportunity, which he has seized. He was ready for the strike with a big stock of goods already there, and he has been shipping steadily ever since. Within the last six months the shipment of shoes to England from the United States has been large, and it is steadily growing. There is no reason why the United States could not hold that market. With their improved machinery and their superior industry they can undersell the natives.

Tool steel is one of the articles in which the United States stand preëminent. They produce the finest steel in the world, and at a price whereby American manufacturers are fully able to compete with the finest English and continental products, and they are doing it everywhere.

Dry goods may be considered a new class of exports, and a rapidly growing class.

American paper is cheaper than any other paper, and several of the London and Liverpool newspapers are printed on it. Nearly all Australian and many South American journals use it.

American moquette carpets are seriously challenging the English article, and are sold so cheaply in England as to have brought about a heavy reduction in the price of the English Axminsters. That trade is increasing rapidly, too.

A very much larger variety of all classes of merchandise might be exported, were it not for the discrimination in freights against American shipments. This is owing to the exclusion by our tariff of return cargo. The new tariff, however, has either reduced or removed the duty upon so many raw materials that, as soon as the manufacturers have fully equipped themselves to take advantage of the new order of things, this difficulty should be largely overcome. A careful study of the world's markets and a comparison of the prices of American manufactured goods with those of other countries make it clear that the door of our export trade is only ajar, but American enterprise and American intelligence and push will undoubtedly throw the portal wide open, and give to the United States the supremacy in the manufacture of nearly all classes of merchandise for shipment to non-manufacturing countries.

Confirming Mr. Eddy's statements, the following official records of exports of American manufactures is interesting :

	1874.	1884.	1894.
Agricultural implements	$ 2,585,016	$ 3,442,767	$ 5,027,915
Carriages and horse-cars	506,827	1,582,459	1,649,154
Railway cars	1,145,067	1,444,039	1,700,521
Clocks and watches	876,105	1,359,690	1,302,813
Coal and coke	2,914,075	5,051,509	12,093,474
Copper and manufactures thereof	259,076	5,595,859	22,132,856
Cotton manufactures	2,947,528	11,585,211	14,340,886
Flax, hemp, and jute	445,825	1,397,772	1,288,912
Gunpowder and explosives	3,092	1,177,922	1,002,126
India-rubber goods	214,798	635,046	1,461,842
Scientific instruments and apparatus (including electrical)	49,890	557,424	1,534,277
Iron and steel and manufactures thereof	11,323,919	21,901,962	29,220,224
Leather and manufactures thereof	5,305,494	8,090,029	14,283,429
Naval stores	3,809,431	3,119,200	6,790,948
Oil-cake and oil-cake meal	72,698	7,115,153	8,807,256
Oils—animal, mineral, and vegetable	44,153,674	50,126,188	47,756,684
Marble and stone	286,530	603,300	1,054,814
Paper and stationery	658,248	1,272,810	2,589,912
Soaps	667,858	740,426	1,139,722
Sugar and molasses	1,801,428	6,316,124	1,209,411
Tobaccco—manufactured	2,642,811	2,530,457	3,849,996
Wood—manufactures of	3,189,445	5,349,720	6,773,724

At the 122d annual banquet of the New York chamber of commerce, among the notable after-dinner speeches was one by Mr. Carl Schurz, to whom had been assigned as a topic, "Foreign Commerce." Said he :

If we wish further to extend and develop our foreign commerce these things are necessary :

1. That we should have something to sell.

2. That we should adapt the goods we wish to sell to the requirements and tastes of those to whom we wish to sell them.

3. That we should be able to sell our goods as cheaply as goods of the same kind and quality are sold by other people in the same markets.

4. That, if we sell to foreign nations, we must be willing to buy from them, one-sided international trade being a contradiction in itself.

You will tell me that there is nothing new in this. Certainly there is not. It is an old story—as old as common sense. But it is amazing how far some people contrive to get away from such evident truths as soon as the practical application is called for.

Last year I was in Europe, and one day dined at the house of a prominent merchant in Hamburg. There were about twenty ladies and gentlemen at the table. The dinner talk brought me one surprise after another. It turned out that most of the ladies present—I think even all of them —had been across the seas, and spoke about Hong Kong, Shanghai, Bombay, Zanzibar, Mexico, Montevideo, Buenos Ayres, Rio, Valparaiso, Havana, etc., as familiarly as our ladies speak about Long Branch, Newport, or Bar Harbor. All these ladies had lived at such places with their husbands,—merchants who were still in business in foreign parts, or had been there in their younger days, either having establishments of their own or acting for German houses, but in either case studying the habits and tastes of foreign peoples and the requirements of foreign markets as well as the export resources of foreign countries, and giving the commerce of their German home the benefit of their studies and experiences. The company I met was, as I was informed, by no means an exceptional one. It rather represented the rule among that class of business men, whose education is scarcely considered complete without the foreign course.

Do you not think that, when we hear of German commerce crowding out that of other nations in many parts of the world, this fact may in some measure be owing to the systematic care with which the study of foreign markets is cultivated? Now, if our young merchants, married or unmarried, devoted a little less time to Fifth avenue, Newport, and Paris, and a little more to Buenos Ayres, Rio, Valparaiso, Shanghai, Zanzibar, and similar places, thus enlarging their mercantile education too, would not that be likely to do our foreign commerce a world of good?

I do not intend to discuss the general question whether our high protective system is, on the whole, a good or a bad policy for the country, but only the narrower question of the relation existing between the tariff and our foreign commerce. And then I say that, as the tariff enhances the prices of the things the manufacturer has to use in the production of his finished article, it enhances the cost of production; and, as it enhances the cost of production, it enhances the price the manufacturer must ask for his finished product to make a reasonable profit; and, as it enhances the selling price of the manufactured goods, it puts them at a disadvantage in the foreign market, renders them unfit for exportation, and thus narrows and cripples our foreign commerce.

The remedy naturally suggests itself. It consists in such a revision of the tariff as will deliver our manufacturing industries of those artificial burdens which increase the cost of the things they have to use in production, thus permitting them to obtain those things as cheaply and advantageously as their foreign competitors obtain them, and in that way giving them a fair chance for the export trade.

We have heard strange doctrines—ancient superstitions revived—in our days: that commercial intercourse with foreign nations is a thing of doubtful desirability; that importing is sinful; that goods may go out of the country, but only cash should come in; that, when an American merchant sends a ship to a European port with a cargo that cost here $100,000, and he sells that cargo in Europe at a profit enabling him to buy a cargo there costing $125,000, and he ships that cargo to South American ports and sells it again at a profit enabling him to buy $150,000 worth of hides and other merchandise to be brought to New York, the balance of trade will be against us $50,000, and the United States have lost that amount. I think the barbarous doctrines I have mentioned do not deserve another word. Let them stew and smother in the depth of their own absurdity.

IRRIGATION SURVEYING IN CALIFORNIA.

By Charles Evan Fowler.

FROM a point of vantage between Los Angeles and Redondo by the ocean can be seen in the spring a sight of grandeur long to be remembered. To the southeast, after a stormy period in the mountains, a peak of the Sierra Madres, 40 or 50 miles away, upholds a cap of snow ; more to the eastward San Jacinto, the most beautiful peak in Southern California, rises snow-capped to more than 10,000 ft. above sea level, fully 100 miles distant ; San Bernardino, the peak which is the basis of all the land surveys, stands, shimmering-white, 85 miles away, rising to an elevation of over 12,000 ft., in a ridge renowned as Grayback ; San Antonio, or Old Baldy, in plainest view, yet 50 miles away to the northwest, has an elevation of over 10,000 ft., and is the highest peak of the snow-capped range to the north, which in supreme beauty upholds such a bounteous supply of moisture for the thirsty lands below.

These mountains hold the snow for some months, and in some of the cañons at a high elevation snow can be found all the year through. The melted snows find their way down the cañons in cold, sparkling streams, which must be conveyed to the desert or dry lands in the valleys to make of them the fruitful orchards or vineyards. Away up at the headwaters these cañons are narrow and rocky, in some places not more than a gorge, whose upright walls reach high above and confine the waters as they rush down the steep grades in tumbling cascades or break in snowy whiteness over a sudden drop of 50 ft. or more. They widen out lower down to hundreds of feet, or to a half mile or more, and in times of flood almost uncontrollable torrents roar down, filling the cañons from side to side, carrying along huge boulders of many tons' weight over a bed of rock *débris*. During the summer months, and until late in the fall, the streams of from a few hundred to thousands of miners' inches' capacity sink in these beds and flow underground, perhaps not appearing again, or coming to the surface as springs below, to form new streams.

It is during these months of quiet that surveys must be pushed and work prosecuted, with the object of making these waters available for irrigation. Nearly all those which were easy to conduct by comparatively inexpensive works have been taken up by the colonists and companies : so that, for new supplies, search must be made at some distance into the mountains, and means devised to convey what has been considered inaccessible.

YUCCA PALM, NATIVE OF THE DESERT.

ON THE TRAIL TO WILSON'S PEAK.

The engineer in charge of irrigation work must start out in an almost unknown region, equipped with an aneroid barometer, hand-level, pocket compass, and a supply of provisions sufficient to last during the trip, to search for streams of such volume as will justify the investment for dams, reservoirs, tunnels, and canals. Barometer readings are made to determine whether or not the water can be taken from the streams at an elevation high enough to enable it to reach the lands as desired, and to ascertain the feasibility of tunnels of reasonable length. The distances have to be estimated, and to do this with any degree of accuracy requires long familiarity with mountains; but the barometer readings prove very accurate in such a climate, and are great aids to the surveys which follow.

Many companies, as is true elsewhere, wish to obtain quick returns from their investments, and spend but a short time in such *reconnaissance*.

The beginning of an extensive survey of a thorough character was made toward the last of March, 1891, by the selection of Banning in the San Gorgonio Pass on the Sierre Madre mountains as headquarters. The country to be surveyed and examined was tributary to "Old Grayback," and comprised some 250 miles to the southeast.

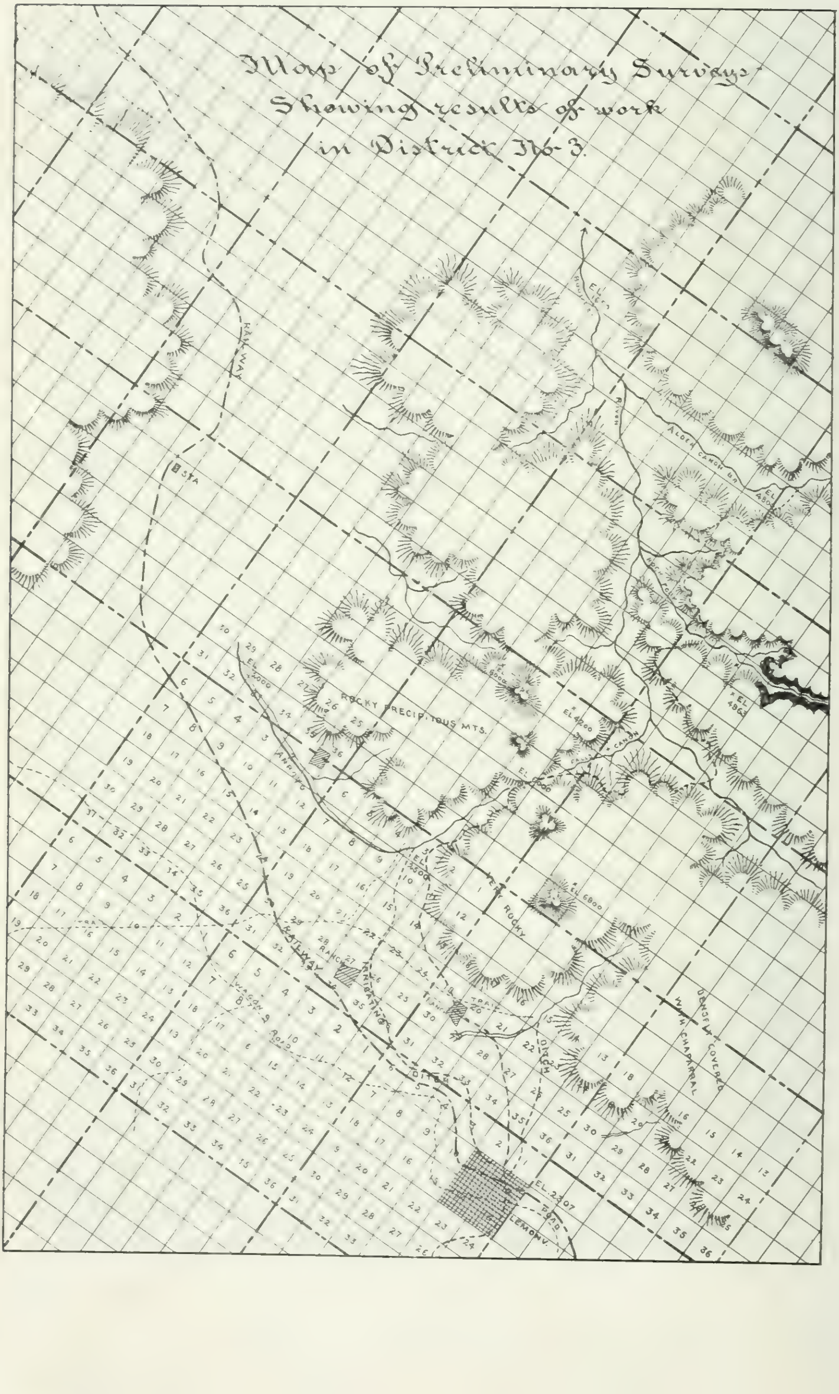
Township plats were secured from the United States land office to use as data in compiling a map of the region; but the section lines had been run by the old surveyors only up to the foot hills, and beyond this were legends—"Rocky, precipitous mountains," "Mountains densely covered with chaparral," "Unsurveyable"—in lieu of the information wanted. Where the lines had been run, out in the open country, distances and bearings were given, and old roads, Indian trails, and washes were shown, many of which had been obliterated or changed long before.

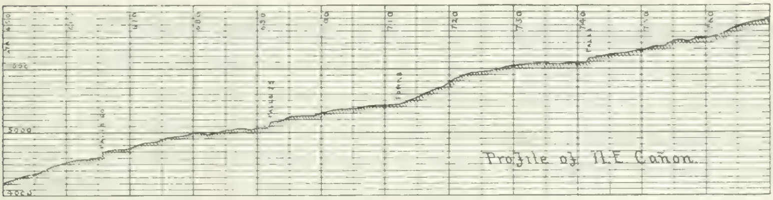
It was imperative that no time should be lost while the dry season lasted; so, while waiting for an office outfit to arrive, a map was begun on a scale of 1000 ft. to the inch, in a manner to cover, as nearly as possible, all the country to be surveyed.

Field work was soon begun by running a preliminary line to connect the future surveys with established land lines. The corps consisted of both transit and level parties. Nearly all wore the wide Mexican sombrero, and high lace boots as a protection from buckthorn, cactus, and rattlesnakes; and, as some of the corps sported knickerbockers, the crowd made a picturesque appearance.

The instruments were a light mountain transit, steel tapes and plumb bobs, flat sight-poles 10 ft. long with plumbed centre lines, hand-levels, a hand-axe with scabbard for each person, and a supply of stakes. The level party used a short Y level. As the corps was away

THE BURRO EXPRESS.


Map of Preliminary Surveys
Showing results of work
in District No. 3.
RAILWAY
STA
RIVER
EL 4863
ALDER CANON BR.
EL 4800
ROCKY PRECIPITOUS MTS.
EL 2000
EL 6000
EL 4200
CANON
FALLS
EL 5000
EL 12500
EL 6800
VERY ROCKY
RANCH
RAILWAY
WAGON ROAD
IRRIGATING
DITCH
TRAIL
DENSELY COVERED WITH CHAPARRAL
DITCH
EL. 2307
ROAD
LEMONV.

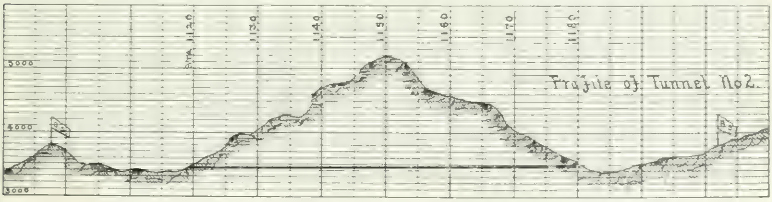


from the streams part of the time, each person carried a canteen, while a large metal lunch-bucket, well filled, was always in charge of the flagman. The transit lines were run up many of the cañons, to be utilized later as connections from the other side of the range. Many of these were nameless; one, having a bee ranch, was put on the map as Bee Cañon, and another, which boasted a stream of water in summer, we called Water Cañon. Level lines were also run and benches established at convenient points, with sea level as datum.

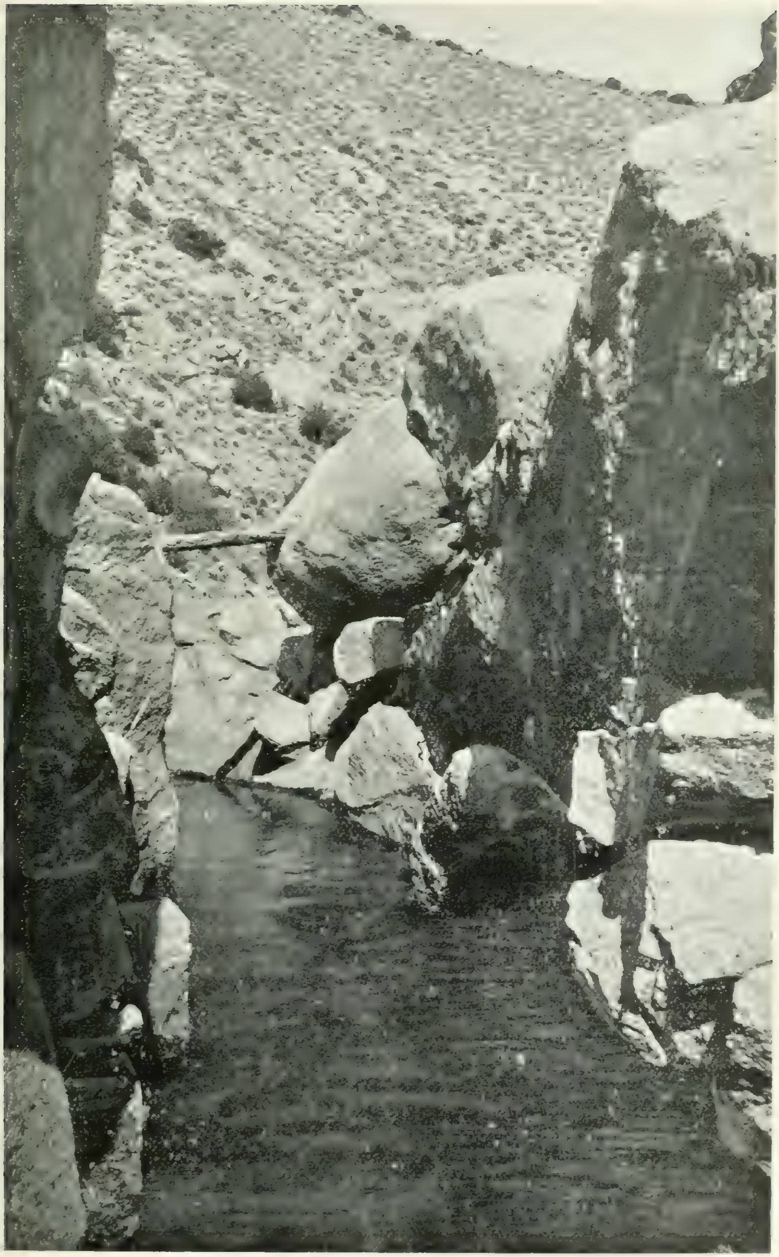
Nothing unusual was encountered in the Pass except the low chaparral, sage brush, and cactus, which were not high enough to interfere with sights and chaining, although, while one was trying to avoid some cactus, a bunch of "Cat claws" would claim attention.

Long sights could be taken in such a clear atmosphere as the eastern slope of the San Gorgonio Pass, and the chainmen were often allowed to go a half a mile ahead before making a new transit point, and on a very clear day sights of 3000 ft. could be lined in with ease. Five or six miles were made in a day, when station stakes were to be set, besides a long drive through the sand to and from work.

Orders were soon received to push work into the mountains, where short sights were the rule,—often, in the narrow crooked cañons only 30 or 40 ft. The work frequently became so slow that it was necessary to make a triangulation for some miles. The topography was sketched in, and points were located by separate intersections when desired. By this time surveys had been carried so far from Banning as to necessitate the pitching of camp nearer to the work. Tents, provisions, and supplies of all kinds were hauled by desert wagons 10 or 12 miles east to White Water Ranch, which was near the mouth of White Water Cañon, and then carried by burro train 13 miles up the



FALLS AT HEAD OF WATER SUPPLY IN SIERRA MADRE.



GRANITE WALL OF HESPERIA CANAL—THE DEEP CUT.

COMMISSARY DEPARTMENT OF CAMP.

cañon to the site selected for camp. The burro train, of eighteen or twenty animals, was kept busy for days, filing up and down the cañon with huge loads cinched on for the up trip of the "sober burro."

While this was in progress, a transit line was taken up and extended by the main cañon. The first day's work was on the edge of the desert, where the heat was so intense that our supply of water soon gave out, and the back flagman was loaded up with canteens and sent to the foot-hills for a fresh supply. How thirsty a person can get while compelled to wait for a drink, in plain view of snow-clad peaks, is never realized until tried. Hard work found us at night near the old adobe or "doby" ranch house at White Water; and, after a wash in the irrigating ditch, and a supper cooked and eaten under the cottonwood trees, we all turned in.

San Jacinto's snow-white peak was glistening in the sun, over 8000 ft. above us, as the breakfast was being cooked and eaten for an early start the next morning.

It was the expectation by this early start to reach a half-way camp up the cañon that night, and we soon came into sight of the huge brown buttes near it, only to learn how deceptive distances appear in such a climate. Evening came after a hard day's work, and the buttes apparently as far away as ever.

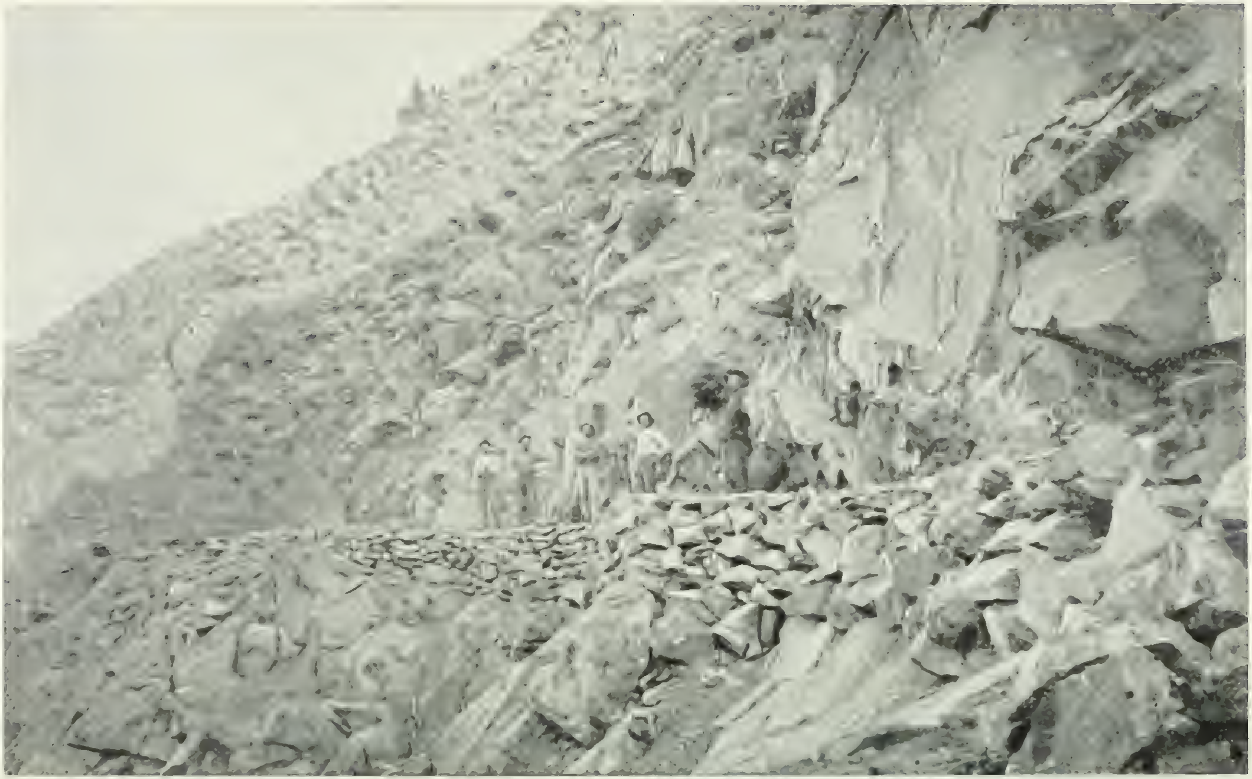
Next day we were between half-way camp and Red Rock Point, a conspicuous hump of red paint rock, in the midst of the great white "wash" nearly 2000 ft. wide. Permanent camp was reached about ten o'clock the next night, after stumbling by moonlight over several miles of the rocky wash; and Sam Lee, the Chinese cook, was called out of bed to get up a supper.

The camp consisted of a cook-tent with small stove, a store-tent, and a dining-tent with a table made of short redwood boards nailed across two poles. Besides these, there were four sleeping-tents, which soon boasted of pole cots with pine-bough mattresses.

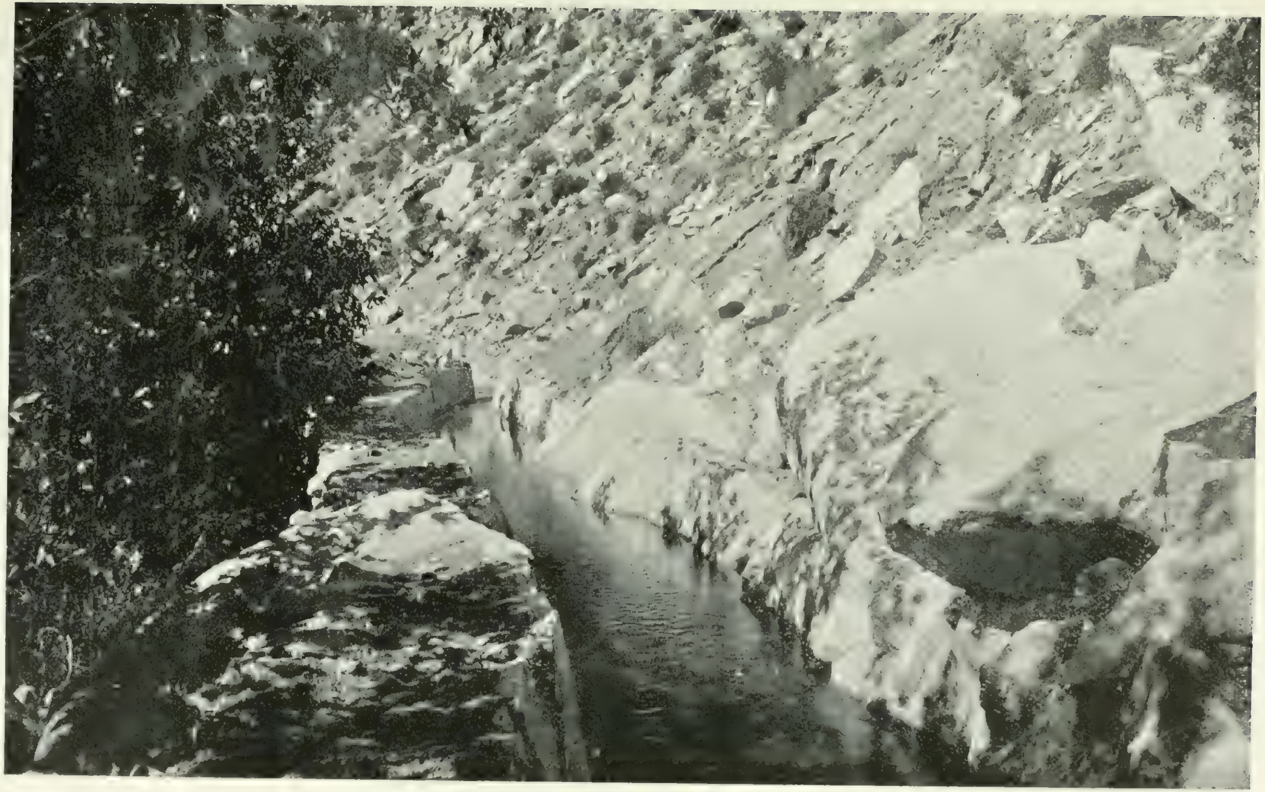
From this camp transit and level lines were run 6 or 7 miles in the main cañons to map all of the country, and the notes were worked up and plotted when occasion offered. For some weeks not a glimpse was had of civilization. Mail and fresh meat came once a week by "burro express" from Banning, about 25 miles *via* the cañon.

The principal streams had been located, lines of level run up them, and the outlines of the cañons sketched in; and we were ready to begin lines up those which had been selected as possible routes for tunnel location. Some of those which proved best had but little to show for it,—narrow rocky openings, winding about, so that very short sights had to be taken, and often requiring more time than some of our longest sights out in the more open country. Frequent waterfalls were encountered, often from 30 to 50 ft. high, and were a source of much delay. Once the only way to carry up our line was to mark a transit point on the rock at the very edge of the falls, over which little water was running at the time, pass up the transit by forming in line, and, after scrambling to the top by holding on to the bushes, to discard a

A HARD BIT OF CLEARING.



ON THE HESPERIA CANAL, SHOWING WALL.



HESPERIA DITCH LINE.

slippery pair of boots and in stocking-feet venture to set up the instrument over the point,—no joking matter.

In some cañons where there was much water a dense growth of bushes and trees had to be cut out, and, as the summit was approached, big spruce and pine from 2 to 5 ft. in diameter were plenty. A profile of such a cañon is shown. On reaching the end at a saddle in the divide, 5000 or 6000 ft. above sea level, grand views were had of the country for nearly 100 miles away across the pass towards the Pacific ocean, and on very clear days the ocean itself could be seen. The view did not seem real, but more like a great relief map, white washes or beds of streams winding about, the rolls and hollows looking like huge wrinkles, while here and there black spots marked the dark green acres of orchard. On cloudy days, at this elevation, one would be in the midst of clouds, and have to stand at the transit by the hour for an occasional glimpse. Or, when the clouds were below, looking like a great ocean, the country, seen through occasional breaks, appeared to be hung in mid-air.

The whole southern slopes of the mountain were dark green or almost black in a velvety coat of chaparral from 2 to 10 ft. high,—scrub oaks almost as hard as iron-wood to chop ; thousands of acres of manzanita, with its beautiful red bark, and crooked branches carrying leaves somewhat like mistletoe and, later, a crab-apple-like berry ; mountain mahogany, greasewood, chemise, and, to the disgust of the axemen, great quantities of buck-thorn that seemed to resist every effort to reach the main stem, which cut like cheese.

Starting down a cañon from the saddle, we had our first experience with this chaparral while all the axes were sharp. The manzanita was most easily broken or tramped off, as it was very brittle ; but by the time we were ready to quit in the afternoon the oaks had not left much edge to the axes, and, with every man chopping hard, the transit book rarely showed a progress of more than 1000 to 1300 ft. in a day. When only running lines through it for closure of surveys or for a connection, stadia readings were taken of from 800 to 1000 ft. from ridge to ridge over it all, although much time was still consumed in forcing our way through it, as often it was so dense that one could walk or scramble over the tops. The bottom of the cañon once reached, and our way cut through the willows, sycamores, and alders along the streams, then a long, weary tramp had to be taken, 4 or 5 miles back over the range, to supper at camp. When this became too tiresome and time-consuming, canned goods would be packed up with ten or twelve loaves of bread and a supply of crackers, blankets rolled up, and all, including cooking utensils, cinched up tight on our camp burros and put in charge of the Mexican driver, who was ordered to follow us up or make

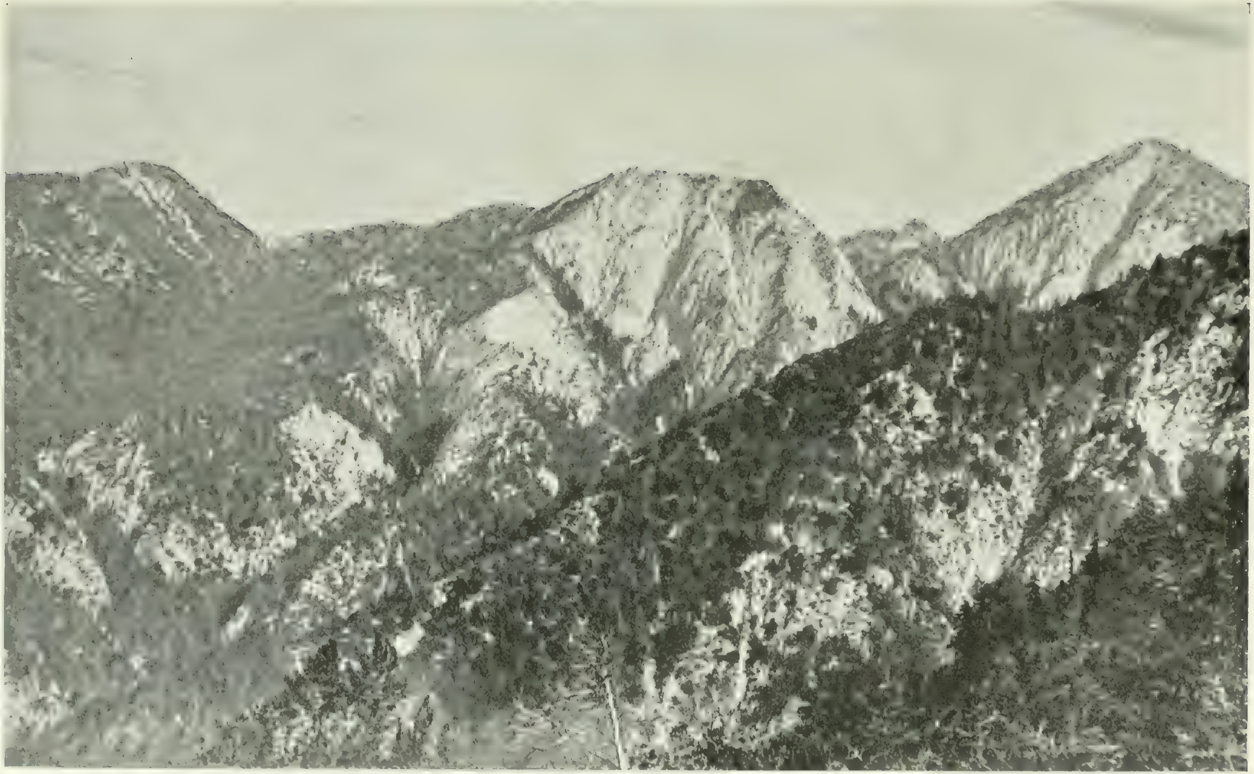
CHAPARRAL.

VIEW ON MOUNTAIN SIDE AHEAD OF SURVEY LINE.

a point ahead of our work. And then every night, until provisions gave out, camp would be made where work was left off. Rolled up in a blanket on the sand, with sky and stars above and a balmy air to breathe, one could have a royal sleep.

When all these preliminaries had been completed, our original map was filled to about the extent shown in the accompanying one, which is the best that can be given from the topography "sketched in" on a preliminary survey.

When, in addition to this, level lines had been located up the desired streams and cañons far enough above the lands to which the water was to be carried to allow for the necessary fall in the estimated distances, the preliminary location began. The elevations were decided



MOUNT DIFFICULTY AND MOUNT DISAPPOINTMENT FROM WILSON'S PEAK.

A MOUNTAIN WASH IN SUMMER.

OVERFLOW FROM WATER GATE IN THE TUNNEL.

upon for the main tunnels, the probable lengths were scaled from the map with gradients which ranged from one in four hundred to one in one hundred, owing to the different materials to be tunneled ; the elevations of the ends were fixed ; and contours were run in the field to arrive at the very shortest distances.

In running tunnel lines straight over the mountains, with no chance to avoid big trees or cliffs, great pines had to be chopped, the axeman often having a very slight footing ; and, when the trees fell, they would go crashing down the mountain-side, carrying tons of rock from the cliff, making a grand sight. Clearing over the cliffs was at times very dangerous and almost impossible.

When all the line was cleared, two parties of chainmen would be put to chaining the line with steel tapes, hand-levels, and plumb bobs. Center lines were also re-run with the field instrument, and back-sights set for use in case the location was adopted.

From these established tunnel portals grade lines were then run around the mountain sides, with assumed gradients and estimated distances, up to the points from which water was to be taken from the streams, and, on the other side, down to the point of delivery. When the grade line is finally established, then begins the final location, which is similar in a general way to that of a railway. Grade and slope stakes are set for cuts and fills, or for canal excavation, and profiles are made of cañons to be crossed, either by high flumes or bridges.

The grades are generally made as steep as possible without causing wash in the channels, and, in rock or cement ditches, range from a few feet up to (occasionally) several hundred feet per mile. The tunnels, when driven in rock, present a very rough surface to the running water, and in a year or two, when it has become necessary to increase their capacity, they are made smaller by a cement lining,—the smoother surfaces allowing a much greater flow in a smaller channel.

Many examples might be given of the canals which have been built around the steep mountain sides ; of high flumes over deep cañons, such as can be seen on the San Diego Flume Company's line ; of hanging flumes on precipitous cañon walls, like those in Colorado ; and of the many trails and expensive mountain-roads which have been built as accessory to such irrigating canals in seemingly inaccessible mountains. But the reader has doubtless gained some ideas of the difficult work which has made and is making Southern California a great semi-tropic garden.

Irrigation is destined, however, to have a large share in the development, not only of Southern California, but of the millions of acres of arid lands in other western States. It is estimated that from two-

VIEW NEAR HESPERIA.

WEST FORK OF THE CREEK.

fifths to one half of the North American continent is arid or desert land, and of the United States nearly all lying west of the one-hundredth degree of longitude is arid or semi-arid. This great domain embraces about 960,000,000 acres, of which only a portion is arable land, and of this there are probably about 20,000,000 acres under ditch or being irrigated. Probably 25 per cent. more of this is arable land, or enough to make homes for millions of people, if water can be conserved and developed in quantities sufficient to serve some of the large tracts not now under ditch.

The number of acres which can be irrigated by a given amount of water varies greatly, being much greater for old land than for new and depending largely on the character of the soil, as well as the appliances and skill of the irrigators. The unit of measure, which is the second-foot or 1 cu. ft. per second, is made to serve in some places only 70 or 80 acres ; but, where more care is used, this duty can be increased to many hundred acres, and in some cases it is claimed to reach nearly 1000 acres by piping the water directly to the point of use.

The primitive method was, and in many instances still is, to divert the water from the stream by an earth-ditch or canal, from a few to many feet in width, to distribute it by lesser ditches or laterals to the highest corner of each field or tract, and to further distribute it by ploughed furrows or lesser laterals to each tree or every portion of a field. This necessarily made a maximum loss from seepage and evaporation, and was very wasteful.

This was then improved upon by substituting cement ditches or wooden flumes for all except the lesser laterals or furrows, thus in great measure doing away with loss from seepage and increasing many fold the duty per second-foot. Still further improvements have been projected by all the older companies, in order to pipe the water directly to the point of application, and thus save nearly all the loss from both sources and increase the duty to about ten times that of primitive methods.

Not only to this source can we look for a large increase in the number of acres under irrigation, but to the great storage-works constantly being projected and constructed, which will store during the wet season millions of gallons of water that would otherwise rush down to the ocean,—a complete loss and constant menace to the horticulturist. These storage-works will develop very slowly, however, owing to the fact that the value of the property which must bear the expense of construction amounts on the average to only about one-hundredth of the valuation of city property using the same amount of water.

Near Riverside, 20 years ago or less, the land was worth scarcely

$1.00 per acre, but now improved land is valued at from $1000 to $1500 per acre, while the unimproved land which can be reached by water is worth from $100 to $300 per acre.

This is not true of all sections, but it is true of many places; and, while fabulous tales are told of the production, it is safe to say that a tract of from 5 to 10 acres in fruit will support the average family, and in good years leave much to spare.

The ordinary potato has in many cases netted $100 per acre; alfalfa, which is used for hay, gives from four to eight crops a year, and nets from $75 to $100 per acre per year; muscat or raisin grapes net from $150 to $300 per acre; peaches, apricots, pears, apples, and other deciduous fruits, from $100 to $400; English walnuts upwards of $250; while the citrous fruits, which require about 6 years to reach the bearing point, attain much higher figures. In the case of navel oranges the net return is from $800 to $1000 per acre. These figures have been carefully collected, and are thought to be fair averages, although much higher ones have in many cases been reported.

As new reservoirs and canals are completed, constant opportunities are presented for the settlers to avail themselves of good locations, and it will be many years before the bright possibilities of the region are exhausted. The hopeful signs are the better forms of construction being undertaken and the great interest being manifested in the meetings and conventions each year which have for their object the furtherance of legislation in the aid of irrigation and irrigation works. as well as the exchange of methods and measures.

Indeed, it is not beyond the possibilities that this interest may spread far east of the one-hundredth meridian, and, in some future years of drouth, the farmer in the eastern and central States may have arrangements for the irrigation of his crops and orchards.

THE IDEAL CITY-ENGINEERING BUREAU.

By Francis Collingwood.

ONE of the most marked characteristics of the development of modern civilization is the ever-increasing diversity in all affairs, whether in business, science, art, literature, or the art of living. There is a constant differentiation going on, and a closer attention to detail, all leading to new occupations, new discoveries, and greater responsibilities on the part of the men who are now doing the world's work.

With this development, there is also a growing complexity, and an interweaving of interests such as the world has never before seen. This interdependence becomes most manifest in cities, and the more so as these increase in size.

The recent utter derangement of the business of a large city by a strike on the electric tramways is a case in point. The serious troubles arising from a break in a water or gas main, or a temporary stoppage in the supply of food or fuel, may also be cited.

Now, while it cannot be denied that among the ancients there were often men of great practical skill, yet the engineer as he now exists is a modern production, made necessary by the development of which we have been speaking, and by his own exertions and accomplishments hastening that development on its practical side at a speed far beyond what it has ever before attained. It does not detract from the honor due to the sagacious business men of our country to say that, while without *money* no great constructive enterprise can be carried through, neither can success be most effectively realized without the boldness and skill of the engineer.

The first point, therefore, to be made is that, no matter how small the community, it will always pay to place work of a public character in the hands of an engineer. The ideal scheme for the development of any town or city would be that the original location and lay-out of all streets and the location and design of all other public improvements should be scientifically done, and the results properly recorded ; and that all additions should be similarly treated. The ultimate saving in time, money, law-suits, and comfort would be immense.

To reach anything like this state of things will require a long educational campaign, and, while not impossible of accomplishment, it seems almost hopeless at the present. In a town of 5000 to 10,000 inhabitants a street commissioner is usually appointed because he knows how to "turnpike" a road. When an engineer is called in, he finds buildings and sidewalks arranged without regard to grades, and what grades there are not adapted to the ground or to any possible system. He finds street lines unmarked and none of them straight. If there are any records, he finds the maps incorrect. Should he propose to do the work necessary to correct this state of things, the money question comes in at once, and, in addition, the opposition of all those who oppose change, or imagine it might affect their property in any way.

As time goes on, the questions of water-works and sewerage become prominent, and it is exceedingly important that from the beginning complete records be made of the exact character, location, depth, and size of all pipes and sewers, and of the description of other constructions. The engineer should be adequately paid for doing the work, and the field-books, properly indexed, should be the property of the municipality. Much trouble has arisen from lack of attention to this requirement.

The difficulties arising from inaccurate surveys and mapping and incongruous arrangement of streets have led in several cities to the organization of a so-called Platting Commission, whose duty it is to examine all proposed additions to the city, as well as all rearrangements or subdivisions of territory, and to see that the streets are suitably laid out with reference to the topography and existing streets, are of the proper width, and are properly marked by permanent monuments. The city engineer is always a member of these commissions, and makes the necessary surveys and examinations.

In recent years other duties have been placed upon the engineering department,—such as the care of bridges and harbors, city property, parks, and buildings. This great range of work has led in the larger cities to the introduction of boards of public works. In most cases these are appointed by the mayor, either with or without confirmation by the council. These boards consist usually of four members, sometimes with the city or chief engineer as the fifth, acting as president. The city engineer is in some cases elected by the board, in some appointed by the mayor, and in some elected by the people. A very apt remark has been quoted in this connection: "Where you want skill, you must appoint; where you want representation, elect." There can be no doubt that permanency in the office of engineer is greatly to be desired, and the appointment should be as far removed from politics as possible. The more intimate his acquaintance with all the elements affecting his work, the more valuable will his services be; and the more free he is from political interference, the more economically can he do his work. The appointment by the board of works would seem, therefore, to be a wise provision, and it has produced good results where it has been the rule.

Where boards are thus formed, the commissioners are not all engineers, although this would be preferable. It is customary for each to take charge of one portion of the work, the president supervising all, but having only advisory powers.

A classification of the duties that may fall upon a city engineer at the present time would be somewhat as follows:

1. Surveys,—maps and other records;
2. Profiles, grades, specifications, estimates, and assessment maps for street-grading and paving;
3. Lines, grades, specifications, estimates, assessments for sidewalk-grading, paving, and curbing;
4. Sewer construction and maintenance, including all estimates, records, and assessment;
5. Water-works construction and maintenance, including all estimates, records, and, in some cases, assessments;
6. Bridge construction and maintenance;
7. Park construction;
8. Harbor and wharf construction and maintenance;
9. Street-lighting;
10. Street-sprinkling;
11. Inspection of buildings;
12. Regulation and improvement of streams;
13. Inspection of work done by various corporations,—gas, electric, &c.,—in so far as they are under municipal control.

In a *small* town these duties are comparatively simple. All work can be done by the engineer and one or more assistants; and, if careful records are made and so filed and indexed as to be readily accessible, nothing more can be desired. The difficulties arise when, through increase in population and territory to be cared for, the work becomes so extensive as to require separate departments for its prosecution; and it is here that widely-divergent systems have been adopted. Yet, while the interests to be conserved are very diverse, the city itself is a unit, and no mistake can be made in so concentrating responsibility and maintaining a thorough subordination of each special department as to secure the harmonious working of all.

An examination of the list of duties just given shows that they can be best fulfilled by engineers; as trained judgment and skill are especially needed in the economical prosecution of all public works. This being true, if there be a board of public works, it should consist of engineers, each at the head of a department, with the city engineer at the head of all as the executive. To each department should be assigned the details of all field-work and the preparation of designs, specifications, and contracts in its branch of work, the construction and inspection of work, and the making of estimates and all maps and drawings for record,—all to be subject to the inspection and endorsement of the city engineer. The latter should be free from all routine matters, to give him time for the study of preliminary designs and such general examinations as would enable him to wisely administer his office.

It is questionable, however, whether a board of works of this kind may not be better styled the engineering department. In the former case it has been usual for the mayor to appoint all the members; but, if a thoroughly good man be appointed as city engineer, he may well be empowered to appoint the engineering heads of departments, subject to removal for cause.

The chief should be appointed by the mayor, and the term of service should be either during "good behavior," or at least long enough to make it worth while for a good engineer to accept the office.

The organization here sketched is in some respects a radical departure from what now exists, but it is based upon sound principles. The city government having decided that certain work shall be done, the subsequent steps of preparing, contracting for, and inspecting the work, or its execution by the force under the control of the appropriate department, become a matter of business, and political considerations should have no weight. A rigid system of accounting must be instituted, but that should be a part of any system. The heads of departments being chosen with especial regard to their fitness for the work in hand, true economy would indicate that all repairs and maintenance might be entrusted to them.

The number of departments to be organized in any case will depend on the size of the place to be served. The first division caused by the growth of a city would probably be into (1) surveys, park work, streets and sidewalks and everything appertaining to them; (2) sewers and water-works, street-sprinkling and lighting, and the regulation of streams; (3) bridges and inspection of buildings; (4) harbor work, if much of it be required.

The special surroundings of each city will indicate best how the division shall be made. As growth continues, subdivisions of these will be made, but nothing should be allowed to interfere with unity of design and management.

One of the most important matters to be arranged has not yet been considered,—*viz.*, the keeping of records, especially of the maps and drawings which accumulate so rapidly. For convenience in the drawing-room, it is almost a matter of necessity that complete copies of all maps and drawings originating in a department shall be at once accessible. It is also true that in a large city the same drawing will be often wanted for reference by some other department, or by a citizen. This will be particularly true of property or assessment maps.

A record division is therefore essential; and, since the duplication of drawings is now so easily accomplished, it would seem desirable that the records should contain the certified originals of drawings, &c., from all departments, copies being made for use in the offices.

As to the exact method of preserving drawings, there is no agreement among engineers. The first requirement is that as far as possible a few standard sizes only be made. It is found that these are best preserved in shallow drawers with trays 1″ to 1½″ deep. Each drawer must be numbered, and each drawing contain the date of entry and the numbers of the drawing, of the drawer, and of the office or department in which it originates. The card system of indexing, where it has been tried, has been much commended, as it enables the recorder to make constant additions without disturbing the general arrangement.

The drawing should be entered on the index under every head which may serve to identify it. No drawing should be taken from its place without a receipt from the person removing it, and the originals of important drawings should never be removed from the office. The person in charge should be obliged to carefully examine and put in place all drawings, as far as possible, at the end of each day's work.

The general question here under discussion is a very large and important one. Towns and cities are the places where a considerable part of the population of a country must live, and everything done by the municipal authorities comes home to a large number of people. If an improper grade be established, some one may have a puddle in front of his door or possibly a flooded street under certain conditions. If a poor pavement be laid, it becomes a plague and annoyance to many. If a sewer be too small or badly constructed, stoppage, resulting in danger to health, may ensue. And so on, to the end of the long list of annoyances, great and small, resulting from poorly-designed or poorly-executed work. Again, if wasteful or dishonest methods be employed, or if political considerations rule in the employment of men, every man's taxes are increased, and living is made unnecessarily expensive. The scheme proposed may be utopian, but the "*ideal*" bureau only is under consideration. The more nearly this can be attained unto, the less burdensome and the more effective will be the result of its operations.

THE PROBLEM OF PURE WATER-SUPPLIES.

By Rudolph Hering.

IN a previous number of this magazine, under the heading "Sewers and Sewage Disposal," it was said that works for the supply of copious quantities of pure water for domestic and public purposes, and those for the subsequent removal of the same as sewage, held a rank second to none in influencing the health, comfort, and safety of the inhabitants of a city. For reasons then given, the removal of the sewage received the first attention, and it now remains to record the essential requirements for a supply of pure water for a community.

It should be repeated here that the recent progress of sanitary science has been such as to reveal, not only the causes of many infectious diseases, but also the means of prevention. Water-supplies polluted with germs of a specific disease have directly caused the propagation of that disease in a clearly traceable manner, while other supplies not thus polluted have protected the users from injury. Greater attention, therefore, is now bestowed upon the selection of a good water-supply, and upon the purification of any water which is liable to become polluted. The responsibility of city officials for neglect to furnish wholesome water can no longer be evaded.

Often enterprising individuals or firms gratuitously offer to the city authorities one or more schemes by which they will furnish "the best" water and in "sufficient quantities." Such parties avowedly desire to make money by their propositions, and unfortunately we sometimes find that this desire obscures the consideration of the health and comfort of the people. But, whether the works are to be built and controlled by private parties or by the city itself, it is the prime duty of the council to see that the water to be furnished will really be of sufficient quantity and of proper quality.

The quantity needed depends on the character of the population and on the uses to which the water is to be put. It varies in different cities from about 25 to over 200 gallons per head per day, where water is liberally used for manufacturing purposes, for elevators, and for public fountains, etc., and where there is little restraint either as to its use or waste. In Allegheny, Pa., the consumption is over 200 gallons per head per day; in Buffalo it is 193 gallons; in Washington, 160 gallons; whereas in Fall River it is stated to be 29, in Atlanta 36, and in Providence 48 gallons.

In a growing community provision should be made for a future population; but it is often a very interesting question to decide how far into the future our considerations should extend. On one side we see the loss of the interest on that part of the investment which for a time does not bring a return ; and, on the other, we see the fact that, when an additional supply shall become necessary, it will then cost more to provide the means of securing it, owing to increased valuation of property and of water rights, than it would have cost to provide them in advance. This matter should receive careful attention.

All running water, be it in springs or rivers, has its source in the rain-fall. Springs that are nearly constant in their flow throughout the year, or rivers whose summer flow is greater than the quantity of water to be withdrawn, do not require a consideration of the rain-fall, when planning to supply a community. In other cases it is all-important, because it is necessary to store in ponds or reservoirs some or all of the rain falling during the winter and spring months, in order that it can be drawn for use during the summer months, when the natural flow of the streams is insufficient. It is frequently necessary to determine with great care the least rain-fall in the locality, both for a whole month and for the dry months, because a water-supply must be measured by the quantity of water available during the dryest seasons, just as the strength of a chain is measured by that of its weakest link.

Sometimes these problems are not easy to solve, particularly where storage is made difficult by the topography of the country. Small streams with an insufficient flow in summer have been utilized in a very satisfactory manner by providing storage facilities. Where it is practicable to build dams which can hold back many millions of gallons of water, we have been able to count on from one-eighth to one-third of the mean annual rainfall as collectible. The rest is lost.

There are some localities where natural storage-reservoirs exist in the form of beds of porous gravel or sand extending over many miles of territory, as, for instance, on Long Island. The rain-water percolates through the soil and fills the interstices of the gravel, from which it may be drawn at pleasure by driven wells or other proper means. It is found by experience in the Eastern States that the storage in gravel, as well as in open reservoirs obtained by damming up valleys, may allow of a daily draft of from 200,000 to 700,000 gallons from every square mile of water-shed the rain water of which can be naturally or artificially stored.

It will be seen, therefore, that, where the selected source in its natural condition is not sufficient to supply the community in the summer months of the dryest years, a careful investigation as to the best and least expensive means of equalizing the flow of the streams throughout the whole year will be necessary. The best examples of this kind in our country are the water-supplies of New York city and Boston, where well-devised systems of storage have rendered comparatively small rivers available to furnish large daily supplies.

Of still greater importance is the question of quality. In former times taste and appearance alone guided the selection of a source, but we have learned that a palatable, clear, and sparkling water may contain poisons or pathogenic bacteria in large quantities, and now we specify that it shall be free from mineral and organic or sewage pollutions. There are many cities where the supply does not fully answer these requirements. The expense of making changes in existing works, or even a surprising lack of appreciation of a more wholesome water, are the reasons. We may instance Philadelphia, with its sewage-polluted Schuylkill river, and the several large cities along the Ohio river, nearly every one of which takes the water unpurified from the river and subsequently discharges its filth into it to injure the healthfulness of the water taken by the towns below.

It is now well demonstrated that certain diseases are caused by certain bacteria, introduced into the body in many cases by means of the water-supply; and it is likewise well demonstrated that we can purify such polluted water and again render it healthful. Nothing but financial inability can now be held as an excuse for not furnishing a pure water.

The low death-rate from typhoid-fever cases in London and Berlin, since the filtration of their water-supplies, is clearly traced to the effect of the filters. In Zurich the typhoid mortality was four per thousand before the introduction of filters, and was reduced to four-tenths per thousand thereafter. Hamburg and Altona, forming virtually one city, but having different water-supplies, furnish another striking case. The former city was drinking unfiltered water from the Elbe, and in 1892 was visited by a terrible cholera epidemic, while Altona, which was supplied with water from the same river below the sewer outlets of Hamburg, but after the water had been filtered, was practically free from the scourge.

The most recent of such demonstrations is in the case of Lawrence, Mass. Its water, taken from the river, contains the sewage of Lowell, situated about 10 miles above. The records of many years show that a short time after a typhoid epidemic had started at Lowell a similar one started also at Lawrence. In September, 1893, filter-beds were brought into use to purify the water for the latter city. Since then another epidemic has existed in Lowell, but for the first time has not been followed by one at Lawrence. Grounds for expecting this result were known to rest in the fact that under certain conditions the typhoid bacteria, although contained in the impure water, do not pass through a filter properly constructed, but are destroyed in it. It is possible to-day, through artificial purification, to utilize sources which formerly would not have been considered.

The many uses to which water is now being put, and the continual increase of population in our cities, make the quantities required so great that springs and mountain brooks do not suffice, and rivers draining large areas must be brought into use. Some of these areas are populated or cultivated to some degree, rendering the water turbid and impure by the admixture of sewage and other waste organic matter. It would be impossible, therefore, in many cases, to furnish large communities with water at a high degree of purity, were it not for the means now in the hands of engineers whereby water which has been subject to pollution may be made pure and safe for consumption.

There are several ways in which an artificial purification of a city's supply may be brought about. The aeration of water may often serve a useful purpose by preventing stagnation in reservoirs and removing any disagreeable taste due to certain gases or a solution of iron. Agitation with certain materials in a fine state of division—for instance, coke or charcoal—has likewise been found an excellent aid to purification. Dr. Frankland found that water could be made absolutely sterile by this means. Agitation with small particles of iron in a revolving cylinder was used to purify the water-supply of Antwerp.

Simple storage in a reservoir allows much of the suspended matter, and sometimes a large proportion of the bacteria, to settle to the bottom, and thus improves its quality. Again, Dr. Frankland found in a number of cases that raw river water running into one of the reservoirs in London contained from five to ten times as many bacteria as the water running out of the same. A further improvement can sometimes be obtained by adding to the water solutions of certain salts of alumina or of iron, before it enters the reservoir. Yet this necessitates frequent cleaning out of the deposit.

A straining through specially-constructed mechanical filters of sand or other granular material, with or without the addition of precipitating salts, has been found to be of excellent service in clarifying, and to some extent purifying, turbid waters. Atlanta, Ga., is probably the largest city where such means for clarifying the entire water-supply has been successfully used. The most perfect and practicable process of purifying water is by slow filtration through sand. European scientists have made many investigations on this subject, but the Massachusetts State board of health has conducted a series of experiments on a large scale in so thorough a manner that it was able to formulate in its annual reports the principles of this method of purification in a more definite, tangible, and practical manner than was possible before. The latest published statement regarding the results of the experiments was made at the Montreal meeting of the American Public Health Association, in September, 1894.*

The best material is pure sand of a certain degree of fineness. Its active depth should be at least 2 ft., and it is found that 1 acre of sand can purify several million gallons of water in 24 hours under favorable conditions, so that practically all the bacteria may be removed. Usually the filters for water-supplies are operated continuously; the new filter in Lawrence, Mass., was designed to operate intermittently, by which a higher degree of efficiency is expected.

After a source of supply has been selected, and storage, if necessary, provided, it then behooves the officials to see that the water is distributed throughout the city by means of suitable pipes at suitable pressures, and in the least expensive manner. The uneven rate of water consumption throughout the day and night, and the sudden demand for large quantities in one locality in case of a conflagration, make it desirable in most cases to have a distributing reservoir near or in the city, into which the water is uniformly delivered by gravity, or by pumping, and from which it is drawn through the distributing pipes in accordance with the demand. Sometimes such reservoirs are impracticable for topographical reasons, as in Chicago, and then ample means for pumping directly into the mains, with facilities for quickly responding to the changes in the draft, must take their place.

The water-pressure must be neither too great, straining the fixtures or leading to waste or inconvenience, or too light, giving insufficient discharge. Water should be expected to flow freely in the upper stories of all ordinary buildings. In hilly cities it is often necessary to have a high- and a low-pressure service, each requiring a separate system of distributing reservoirs and pipes.

The pressures in the pipes should ordinarily range from 20 to 80 pounds per sq. in. Where they are high, and where the loss of property due to fires cannot be very great, it is customary to utilize the pressure in the pipes, instead of fire-engines, for putting out fires. When this is to be done, the designing engineer must see that sufficient pressure exists everywhere for this purpose, so that, with the greatest hose-length in use, and under other usual conditions, enough water can be thrown upon the fire.

It is a common mistake, due apparently to motives of supposed economy, to make the pipes or mains too small. It is not unusual to find them only 4 in. in diameter or less, when supplying extensive territories. In case of a large fire, the draft upon such a pipe is so great that the pressure and the supply become seriously deficient. The sizes should be so proportioned that, both for fire and domestic purposes, the quantities and pressures in any part of the city will be ample.

---

* "Sand Filtration of Water." By George W. Fuller. *Journal American Public Health Association*, January, 1895.

It is a matter of importance, particularly where the water is not of the best quality, to so unite all the pipes that there can be a complete circulation, sometimes in one and sometimes in the other direction. So-called "dead ends," or the abrupt termination of a pipe, should be avoided, because a stagnation of the water is possible. Furthermore, when there is a sudden change and a large draft at one point, a circulatory system will permit the water to be drawn at a given point from both directions, thus more than doubling the quantity available.

The net-work of the distribution requires still further attention. With a main in every street, it sometimes makes a considerable difference in the total cost whether the largest pipes are laid through the middle or along the periphery of a certain district,—the most economical location being, as a rule, through the streets where the greatest draft is expected. Every locality has its own economical problems, which a competent engineer will not overlook.

The distributing mains should be capable of being cut off by valves at suitable points, so that, when repairs or new connections become necessary, only a comparatively small district need be deprived of water. A careful study may make it practicable to economically shut off no more than two or three blocks at a time.

Hydrants should be placed sufficiently often to control a fire occurring at any point. It is customary to have from ten to fifteen to every mile of pipe in residence districts, and from twelve to fifty per mile in business districts where valuable merchandise is concentrated. Yet it must be remembered that a closer grouping of hydrants will not alone suffice to deliver a greater quantity of water. The sizes of the mains must correspond to the frequency of the hydrants.

Space does not permit us to consider the ways in which city authorities should control the use of water by the people, and regulate the plumbing so that waste and damage shall be prevented. Suitable ordinances should be adopted to protect the supply from misuse and prevent it from endangering property.

The method of paying for water should likewise receive careful attention. Measurement by meter should be adopted wherever practicable, as the fairest method both for the consumers and for the city, provided there is a fixed minimum rate which permits of an ample amount of water for legitimate use. Instance the city of Atlanta, where over 89 per cent. of the quantity consumed by private parties is metered, with the result that waste is materially reduced, and the *per capita* expense of pumping and purifying the water is kept very low.

When meters are not used, the charges should be governed as nearly as possible by the ratio of the quantities probably consumed. Unfortunately this is not always the case, as the usual water tariff frequently contains rules which favor some consumers and unjustly impose greater charges upon others.

Finally, an important question for city officials to consider is the ownership of the works,—whether the city shall own them, or a franchise be awarded to a private corporation to supply the water to the inhabitants. Over one-half of the water-works of the United States belong to private companies. The largest cities, however, are generally found to own the works, while in the newer sections of the country, or those which develop less rapidly, we find a higher percentage of private works. One reason for this lies in the fact that the larger cities, having better credit, are better able to raise the necessary capital; another lies in the feeling that in large cities the works can be better managed in the public interest. Therefore we find that, of the fifty largest cities of the United States, seventeen have, within the last 50 years, changed from private to public ownership, while but one city* has sold its works to a company. Nevertheless, it often occurs that for financial reasons, or on account of a prejudice against incurring a greater debt, serious objections are urged against a town owning its works. It is not always realized that by the franchise system the taxpayers generally assume a greater burden than by public ownership. Still there are many cases where private companies are preferred, and are even necessary, to enable the inhabitants to secure the benefits of a supply. It then becomes exceedingly important that the city officials thoroughly inform themselves of the many intricacies of the subject before granting the franchise, so that they can properly guard the interests of the citizens. Before awarding a franchise, the wisdom is apparent of thoroughly investigating the claims of the promoters, the character and full extent of the proposed supply, the storage facilities, the intended distribution system with its appurtenances, and the available pressures and deliveries, with reference to domestic and fire supplies. The proposed pumping machinery and purification plants, if needed, should also be subjected to careful scrutiny, so that they will undoubtedly do the intended work; and, lastly, the estimated cost of the entire system and the proposed tariff charges, both for public and private purposes, should be conscientiously considered, so that not only a reasonable profit may accrue upon the invested capital of the company, but a protection against ill-proportioned or exorbitant rates be guaranteed to the citizens.

---

* New Orleans, La., bought its works from a company in 1868 and sold them to a company in 1878. *Manual of American Water Works for the year 1891.*

POWER, LIGHT, AND HEAT IN CITY BLOCKS.

By J. E. Talbot.

IN considering the question of the cost to the consumer of obtaining a supply of electricity for lighting or power, it is very commonly assumed that, unless the quantity required is likely to be very large, the most economical plan is to arrange for receiving a supply through the street-mains from the most available central station. This, as a general proposition, may be admitted without question, but it is an old maxim that "*cessante ratione, cessat lex ipsa.*" If the very causes that have been instrumental in the spread of central-station lighting to the partial exclusion of isolated plants are, in some cases at least, no longer operative, then the whole question is re-opened.

The controlling considerations which led to establishment of the system of central lighting and power stations were the greater economy of large units, the longer "hours of earning," and the lower cost of operation due to the centralization of business and *personnel*,—the same centralizing tendency which leads to the formation of our much-berated "combines," monopolies, and trusts. It is true that it would scarcely pay a consumer requiring not more than one or two hundred incandescent lights to instal an isolated plant, provided it were practicable to obtain current from the street service at a fair price; and it is further true that a large number of the existing isolated plants were put in operation at a time when, or in a situation where, a reliable central-station service was not available. Let, however, the capacity of the plant be increased to 100 or 200 h. p. or upward; then we begin to approach conditions comparable with those of the central station. Take, for example, the case of a large "block" or "square" in one of our principal cities, and we find a population or occupancy equalling or exceeding that of a fair-sized town. Such a block may contain a hotel, a theatre, an express office, a newspaper office, and stores of various kinds, as well as a number of light manufacturing industries, so that the power required in the form of electric current for lighting, for motors, and, in an increasing degree, for heating and cooking purposes, may easily run up into hundreds of horsepower. Such a block, with the buildings upon it, may easily have a value of several million dollars; it may belong to one or several owners, and may possess a portion or all of the above-named characteristics of occupancy, and even more. These and other considerations materially modify the conditions of the problem in different cases, but in all there will certainly be the requirement of *light*, and, in nearly all, that of *heat* (almost universally in the form of steam distributed to radiators), as well as *power* for elevators, fans, sewing-machines, lathes, pumps, and tools of different kinds. This being so, it becomes necessary for the proprietor, or proprietors, to provide some kind of steam plant, or, it may be, more than one, at a cost of several thousand dollars, and also to provide skilled labor for the operation and maintenance of that plant. The tenants may obtain their light and power from the owner, or they may provide them independently of him.

Now, following out the very principle of centralization and economical operation which has led to the establishment of existing stations for the distribution of current, let us assume that the proprietor, or combined proprietors, establish a central station of their own for all purposes within this block adapted to service by the electric current; then the question arises: Is there not in such a condition the potentiality, not only of economy in actual requirements, but also of some profit? And in both cases would these not be greater than they would if the necessary current were purchased at the usual rate from a company operating a central station, assuming such to be available? The answer to such an inquiry must depend upon various considerations. In the first place, such a proprietor already has the real estate and buildings, as well as the steam plant, subject to the necessary increase required; he has already provided the necessary fuel, labor, and supplies, subject also to some increase; the wiring and fixtures would be furnished by him in any case. Against this, he will receive a considerable revenue from his tenants, which would otherwise go to the gas or electric-light company. It is true that in the operation of his plant he cannot expect to obtain as high a degree of economy as is possible in a large central station, but, as a set-off to this, there are many expenses that he would not have to bear. Eventually it is the *consumer* that is depended upon to make the central station remunerative. He it is, in the end, who has to pay the dividends, the interest on the capital invested in the real estate and buildings, the steam and electric plant, and the complicated and expensive system of canalization. He has to pay the salaries, wages, taxes, insurance, and bad debts; if the revenue will not meet these charges, more revenue must be extracted from the consumer, or the central station must stop business.

No very exact figures can be given as to the actual additional cost of providing electrical facilities of the kind suggested, but some data may be presented, throwing a little light on the question. The quantity of additional fuel needed can be approximated by estimating a consumption of 5 lbs. of coal per h. p. hour, which, at $3.00 per ton, gives a fuel cost of ¾ of a cent per horse power (say 10 16-c. p. lamps) per hour. Considering the staff of engineers, firemen, janitors, watchmen, etc., which would necessarily have to be carried on a plant or establishment of this nature (even if an electrical outfit were not provided), some one of whom would necessarily be on duty at all times during the 24 hours, the *additional* labor required would be comparatively little, while the extra oil, waste, water, and sundry supplies would be but a trifle. Steam at a pressure of perhaps 120 lbs. would be used, if the most economical engines were employed, but the entire heating of the block could be taken care of by the exhaust steam, from the various engines if the heating apparatus were properly installed to prevent back pressure. If electric elevators are used, the cost of a hydraulic system is, of course, saved, to say nothing of electric as compared with hydraulic means.

It is not to be assumed, of course, that every city block is adapted to such a light and power service as that which has been suggested; the writer has, however, now in his mind an actual instance of a block containing one large hotel of perhaps five hundred rooms, one large newspaper establishment, four restaurants, several small industries (such as tailoring, metal working, electro-plating), Turkish baths, a drug store, a book store, telegraph offices, many private business offices, and a police station to look after the morals of the whole. Five thousand incandescent lights connected, with some multiple circuit arc lights (and perhaps a search light for the police station), would not more than fulfil the requirements for illumination, and with say eight or ten elevators, together with printing presses, sewing-machines, laundry apparatus, tailors' heating-irons, soldering-irons, coffee urns, and motors for ventilating and light manufacturing, some 250 to 300 kilowatts in the form of light, power, and heat are plainly "in sight."

That great desideratum, a constant, or at least a continuous, load throughout the whole 24 hours, can be more nearly realized in this case than with the usual isolated plant. Take, for example, the case of ten elevators; some of these will run say 10 hours a day only, others 15 to 18 hours, and one or two day and night. For an elevator having a load capacity of 1000 lbs. and running 240 ft. a minute, a maximum horse power of 15 may be allowed, while the *average* load will not exceed one-third of this; allow, therefore, 50 h. p. Then, again, as to incandescent lights (or arc lights on parallel circuits) in such a block as we are now considering, although naturally the bulk of the lighting would be from 4 p. m. to 11 or 12, yet a number of lights would be needed all day or at intervals through the day. Kitchens, the back part of restaurants, cellars, laundries, billiard-rooms, hallways, inside offices, vaults, porters' rooms, lavatories, &c.,

would provide an all-day load which, on a total number of 5000 to 6000 lamps connected, would not be over-estimated at 30 to 40 h. p. Motors for light manufacturing work, fans for ventilating, and motors for washing-machines and a variety of other purposes, will also add to the earning capacity of the plant during the day time, and then, in the slack hours from midnight until early morning, there would be the newspaper press-work in addition to the lighting of the newspaper offices, exterior arc lights, and incandescents in the hotels and elsewhere. Thus, it will be seen, no inconsiderable portion of the electric installation would be continually in operation, and, by a judicious selection and arrangement of units, could be kept working at maximum efficiency at all times.

It may be objected, it is true, that we are proceeding on an unwarranted assumption that the light, heat, motive-power, ventilation, and the like, provided for occupiers will be appreciated by the tenants on a money basis, so that a reasonable return on the investment may be anticipated. In New York, Chicago, Denver, San Francisco, Cleveland, and the other modern and progressive cities we think there can be no question that offices, stores, workshops, and other places supplied with such conveniences would find tenants much more readily, and at higher rentals, than the old, dingy, stuffy, gas-befouled premises of a rapidly-disappearing era, some of which are still to be seen in our more "conservative" cities. In modern building indeed, it is frequently the case that electricity is the only illuminant for which provision is made.

In the absence of definite figures only an approximate comparison can be made of the cost of production of electric energy in such a plant as that under consideration, with similar cost in a central station, but the analysis of data from a number of central stations shows that the actual cost (omitting interest on capital and dividends) of delivering one kilowatt-hour* to the consumer does not exceed 7 cents, and is in some instances considerably less, while the price charged averages about 20 cents. The cost of fuel, under central-station conditions, averages from 1/5 to 1/4 of the total operating expenses, and, although a "block" plant could not anticipate quite as high a fuel efficiency as a well-managed central station, yet in such a case the other items (making up the greater part of the cost) are either absent or largely reduced. No provision has to be made for paying dividends on watered stock; no large salaries to superintendents and experts; no wages of inspectors and outside men; no repairs or maintenance of outside conductors ; no additional real estate and buildings ; trifling loss in conductors from station to consumer ; less taxes and insurance ; and less expenditure for repairs. The whole installation would be directly under the eye of the proprietor, or man in charge of the plant, and changes in wiring or repairs could be made at cost by an employee of the establishment. As to the method of charging the tenants, the price of their supply, might, as to light, be included in the rent, or be fixed by contract (so much per lamp per month) or by meter, according to circumstances. Motors are customarily owned by the consumer, and power is charged for at their rated capacity per month, the tenant using all or any portion when and as he pleases. The details of the service will regulate the price to be charged, in the absence of a fixed rate per kilowatt by meter. Thus the running of ventilating fans may be considered almost a continuous full-load service ; the elevator service is intermittent and variable ; sewing machines, lathes, drills, &c., intermittent and of small average,—so that the actual power consumed in any given period may be three or four times as much in one class of service as in another of nominally the same capacity. We do not, however, purpose here to deal with the details of this work ; these must, from the nature of the case, be left for consideration in connection with the individual instance.

---

*For the benefit of the non-electrical reader we may explain that a kilowatt is equal to about 1⅓ "h. p." The "watt" is the electrical power-unit, and the ordinary lamp of 16 c. p. requires from 50 to 60 watts.

The use of storage batteries to relieve the dynamos for the supposed comparatively short period of maximum load might suggest itself. It is believed, however, that in the present state of that art in this country, taking all circumstances into consideration, this would be an advisable addition.

In the foregoing remarks it has been taken for granted that occupants of offices, stores, or premises of the class involved in the consideration of this subject will avail themselves largely of the conveniences afforded ; but occasionally an individual might be encountered who has derived his ideas of life from the Plymouth immigrants or from the period of William Penn, and to him these " new-fangled " notions might seem distasteful ; yet, after a short actual experience of the resources of modern civilization, he who " came to scoff " would " remain to pray."

By no means have we dealt with every aspect of this question ; rather would we suggest matter for elaboration and inquiry, the local conditions in every case materially affecting the problem. At the same time it does seem certain that in very many instances such a " block " plant as has been suggested would enable complete electric service to be obtained under conditions where otherwise it could not be had, or at least not so readily, conveniently, or economically.

WOOD-STAVE PIPE FOR CONVEYING WATER.

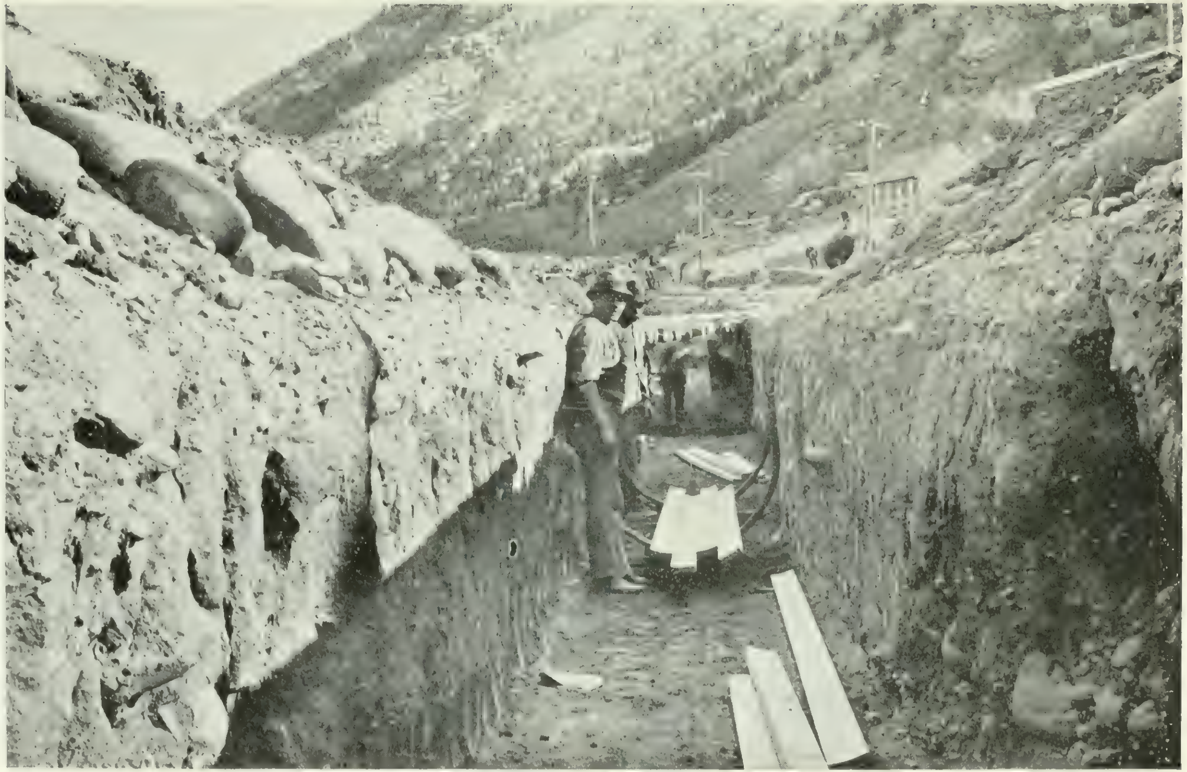
By Arthur Lakes.

"NECESSITY is the mother of invention" is a trite saying. We may add that simplicity is generally the character of important inventions. Both these observations seem illustrated in Mr. Allen's invention of the wooden stave pipe, which, some think, will revolutionize the long high-pressure conduit system.

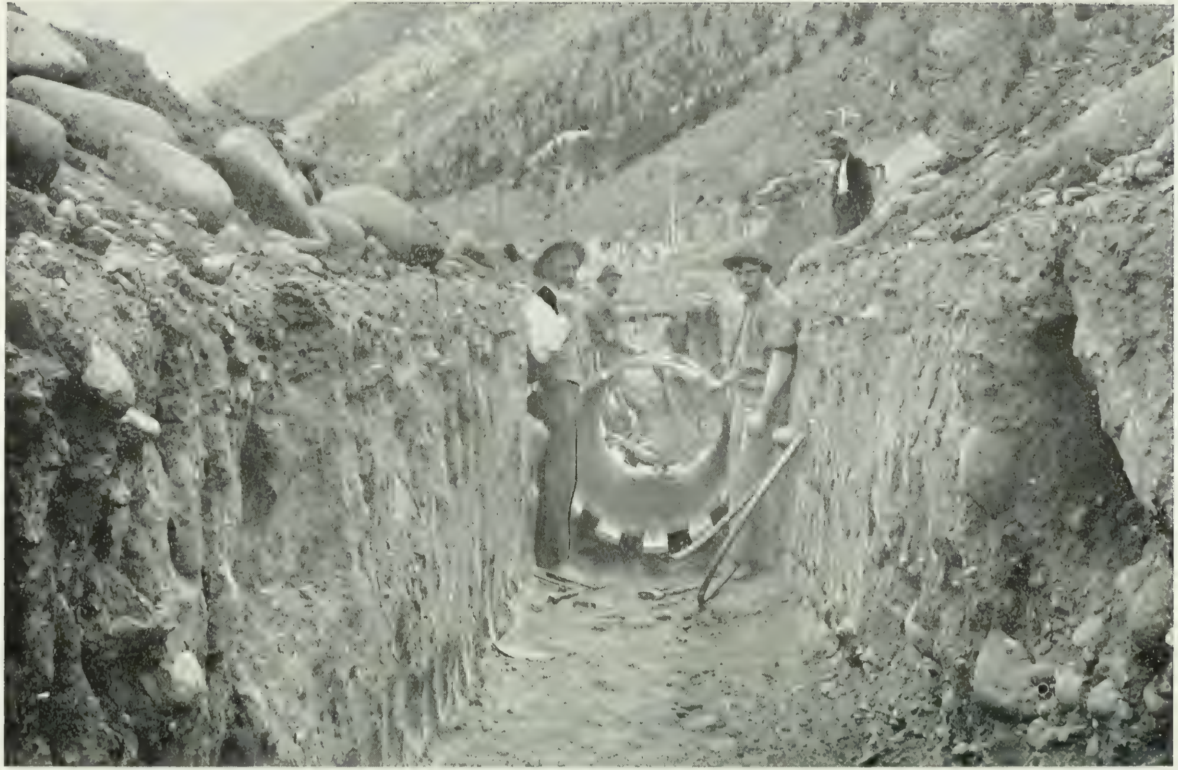
Any one who has passed through a frontier experience knows the wonderful fertility of invention as well as power to adapt materials displayed by the frontiersman when he has to rely wholly on himself, there being no stores at which to buy this and that. He looks around him to make what he can out of what lies nearest him. In the backwoods of Canada a woodsman can make almost anything out of wood with his axe. Give a frontiersman on the plains a good supply of tin cans, and he will do anything—from shingling his dug-out to making a set of dinner-ware or a lantern. So, in the present instance, the necessity of bringing a long and voluminous supply of water to Denver from the mountains many miles away led Mr. C. P. Allen, chief engineer of the Denver water works, to look about him for some material less costly than iron or earthenware, capable, too, of a larger diameter and capacity than the ordinary metal pipes. He settled upon that material which lay nearest him, and the cheapest,—*viz.*, wood ; and the wooden stave pipe was evolved. It seems now as if, by an unexpected and retrogressive evolution, the conduit system was about to evolve from an iron and earthenware age to a woodenware age. Nor is this evolution unparalleled or without analogy. The early backwoods architecture evolved from a wooden age of log cabins and wooden sidewalks to one of brick and stone. Nevertheless in many parts of America, notably in California and on the Pacific coast, wood has shown itself the fittest, and the cheapness, lightness, and elegance of the California redwood buildings have caused them to supersede the more massive structures of brick and stone.

Nor was it in the present case a mere temporary makeshift of no durability, for the wooden material bids fair to equal, if not to outlast, the oxidizing iron and frost-cracking earthenware ; and water carried by it is not contaminated by rust, oakum jointage material, or other impurities. Its advantages and virtues, however, we shall reserve for a later place in this article.

The cause that led Mr. Allen to invent the stave pipe was the condition of the water works of Denver.



BEGINNING OF A SECTION AT RAILROAD SIDING.



SECTION COMPLETE.

BEGINNING OF THE BUCKLE.

These works, in their infancy in 1871, consisted of a pair of Holly pumps drawing water from a large well in the gravel bed of the Platte river. There were then but 6000 inhabitants. In 1879 a higher source of supply was sought above the sewage contamination of the city. New works were located in West Denver, where it was possible to utilize the water power of the river; and a canal 2 miles long, called Archer lake, was built from the river with a vertical fall of 30 ft., and also a battery of turbine wheels and set of four Holly horizontal pumps. The canal accumulated much silt and vegetable matter, so that in 1884 the company decided to seek a purer supply higher up stream by developing the underflow in the gravel beds adjacent to the river. The development was planned and executed by Mr. Allen, and was the originating motive for the evolution of the wooden stave pipe, which has since come into extensive and general use.

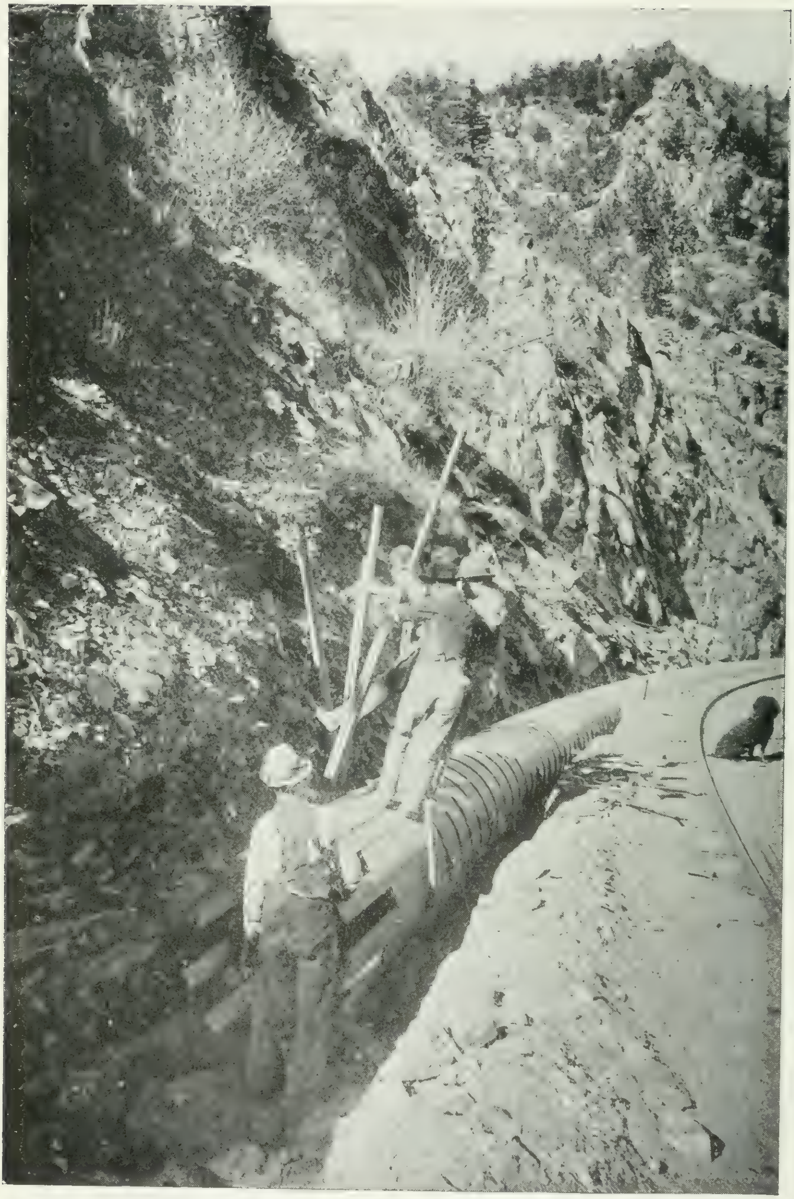
The grade from the gravel beds to the works was so slight that a very large pipe was needed to carry the volume of water required, and the maximum pressure upon it was so low that there seemed to be an especially good field for the employment of material cheaper than iron. It was finally decided to lay a wooden stave pipe 48 in. in diameter, banded with steel rods, the top to be of California redwood, the lower part of Colorado pine. The cribs or galleries gathering the water and feeding the pipe were made of rough lumber 4 ft. wide and 1 to 4 ft. high, with open joints, the tops of which are some 6 ft. below the bed of the lower water surface of the river. The water filtering through gravel was clear and pure and a great improvement on preëxistent conditions. The pipe terminated in a 12,000,000-gallon reservoir. From the reservoir the water was pumped into the mains.

The success of the Platte underflow led to similar developments on Cherry creek, which heads in the high table-lands of the Divide. The slope of the area rendered it practicable to bring over its underflow on a short conduit, and in 1886-7 a wooden stave pipe 37 in. in diameter and 5 miles long was laid to tap a system of semi-circular cribs sunk in the bed of the creek 25 ft. below the surface. When this pipe was completed, the flow into the city reached 9,000,000 gallons daily.

The Citizens' Company was the next to adopt the stave pipe; one 30 in. in diameter was laid from Platte cañon for 20 miles, 16 miles of which were of stave pipe. The wooden pipe was banded to withstand a maximum pressure due to 185 ft. static head.

The total number of band sused was 271,900, which, divided by the length, gives an average spacing of 3.86 in.—sufficient for an average head of 70 ft. throughout. The cost of this wooden pipe was very moderate: 1,869,000 ft. of B M Texas pine, surfaced, at $27.50,

GENERAL VIEW APPROACHING SECTIONS.

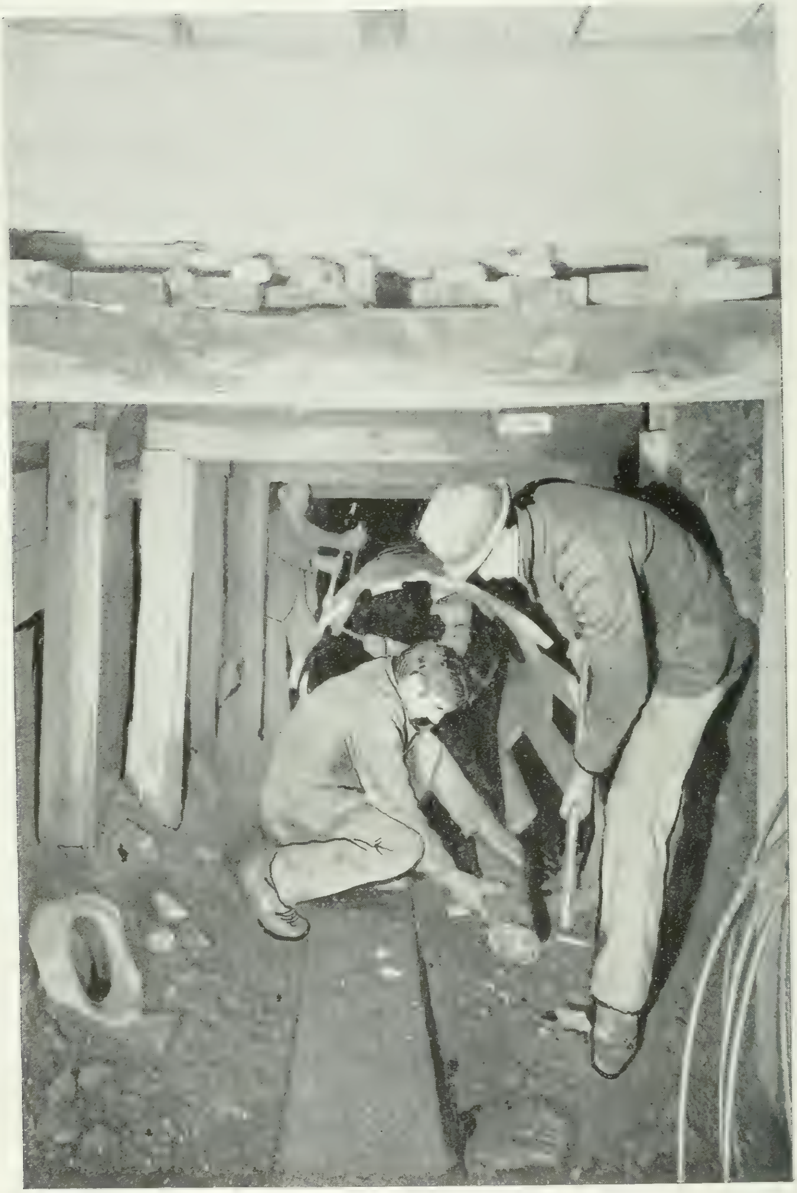


SWINGING PIPE INTO POSITION ON CURVE.

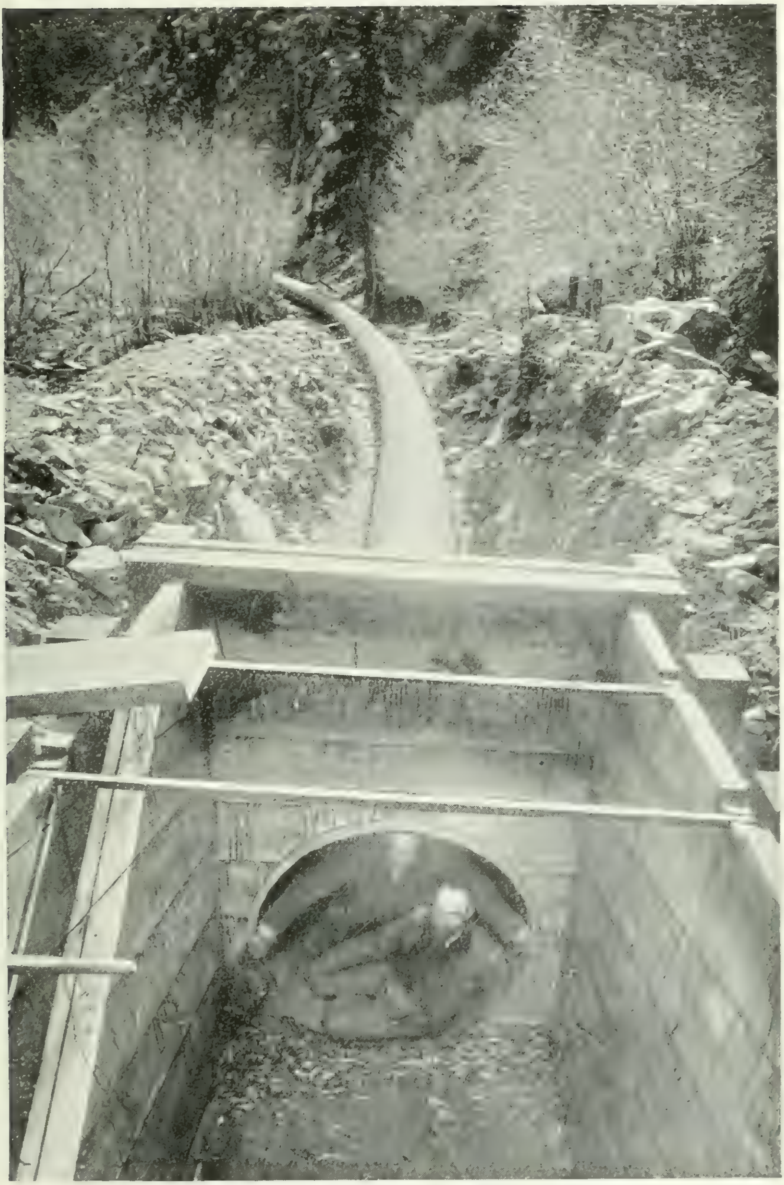
$51,399.28 ; 271,900 ½-in. steel bands and shoes, $54,299.03 ; erection of pipe at 5.1 cents per band (contract), $13,856.03 ; total, $119,564,86,—an average of $1.36½ per foot. This wooden pipe, having a smooth interior which becomes smoother with use, has a greater carrying-power than cast iron of equal diameter. A still larger pipe of 34 in. diameter, and another of 44 in., were added later. On one occasion, having to make a temporary arrangement with a high line ditch to use its tunnel and take its water by a waste gate into the 30-in. pipe, a short flume, forming a spanning bridge, was made, which showed admirably the strength of the wooden-pipe system. It was made of two 13-in. wooden pipes 104 ft. long. These pipes were spread apart 12 ft. at the ends, and brought together at the center for a distance of 20 ft., where they were tied with iron bands. This, which was intended as a cheap temporary crossing, was novel and proved stanch and effective. The arch was built on light false work and finished in a week. The pipe was then filled with water, and used as a foot-bridge, showing little vibration. "Thus," says Mr. Schuyler, in his report on the Denver water system, "the entire supply of a city of 150,000 people is conveyed in wooden pipes or mains,—a novel idea, but one that has achieved an enormous saving of cost and has proved eminently successful."

I had a good opportunity of studying such pipe, in all its progressive stages of construction to its final completion, at the Stanley consolidated mine, above Idaho Springs, Colorado, where it has lately been introduced to carry the water of Clear creek under high pressure to a water-wheel working the air-compressing engine of the mine. Standing on the high dump of the mine, and looking down on the pipe below, it reminds one of a gigantic red worm winding along the sinuous banks of the creek beneath the steep cliffs of the cañon. The pipe is about 1 mile in length and 36 in. in diameter, and carries water at high pressure down a gradually-descending grade to the water-wheel near the air-compressor. The pipe is painted red and made of boards of prepared lengths of Texas pine. Each board is dressed into a slight section of a curve of the pipe. The pipe is hooped with mild steel bands from end to end, the hoops coming much closer together towards the lower end, where the pressure is greatest. The boards, or staves, have a thin tongue of metal at the end, which is driven into a corresponding groove in the next piece, making a firm joint. A bend also along the side of the board, when driven home, makes a tight fit between boards without the use of oakum.

The round steel bands are joined by an ingenious and very simple device. The band or rod has at one end a square head of special form, and at the other a thread is cut 5″ in length, for which distance



BUILDING PIPE IN TUNNEL, DRIVING STAVES.



SHOWING INSIDE CONNECTION OF PIPE TO PENSTOCK. PIPE 48 IN. DIAMETER.

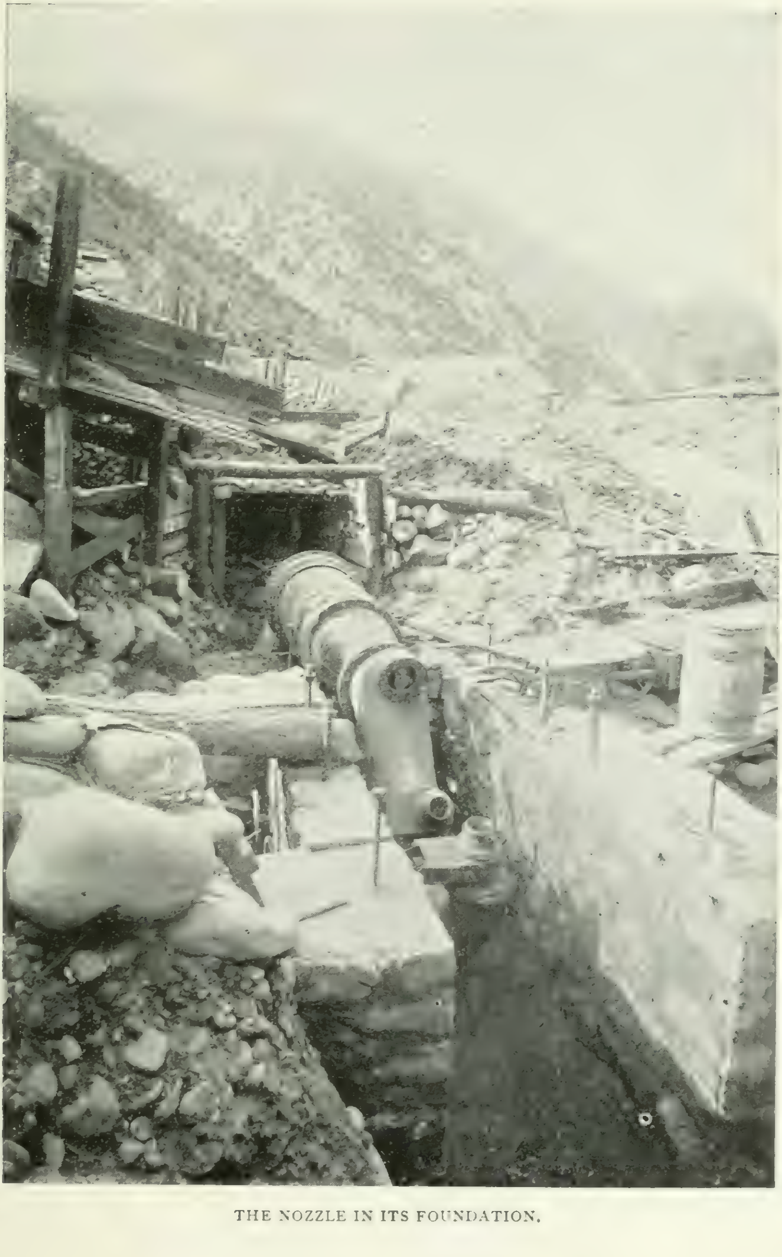
the rod is upset. The threads are cut of less depth than the standard thread, and the nuts are made thicker than ordinary. The bands are shipped as straight rods in bundles, bent on the ground by hand around wooden tables. They are dipped in asphaltum or painted with red paint. After the bands are in place on the pipe, the threaded ends are again painted before the pipe is covered with earth.

The coupling shoes are of malleable iron. A recess near the bottom of the casting is made to receive the head on the end of the band, and the slot in the top receives the threaded end of the band directly over the head.

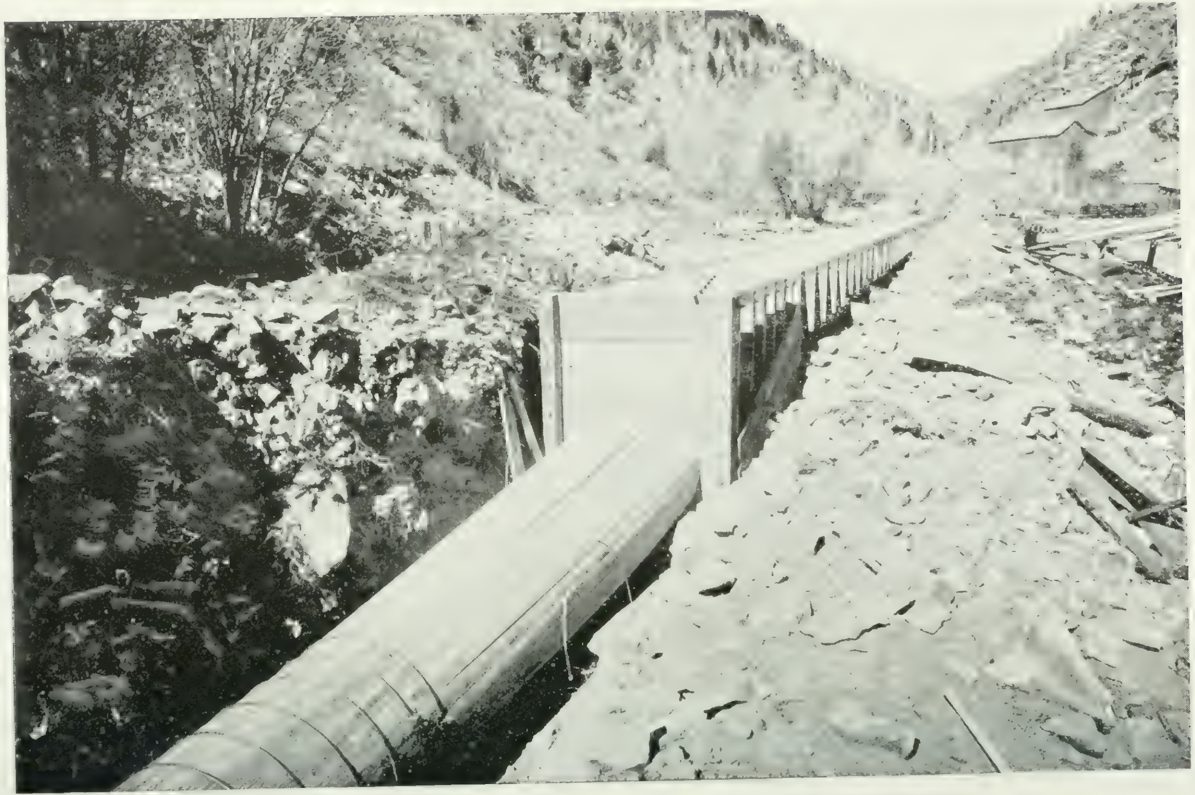
The first step in construction was to build a dam and penstock. Then a trench was dug 4 to 5 ft. deep to receive the pipe, and a little wider than the pipe that the men might work by the side of it. This was mainly in loose river drift. In one or two places they had to make a short tunnel. The next step after the material and hoops were all on the ground was to lay down two U-shaped outside forms on the bottom of the trench 10 to 12 ft. apart; on these the bottom staves were placed, with the tongues on the ends to join the bottom half of the pipe. Inside of this was placed a ring of proper size. The remaining staves were added separately, and the nuts partly tightened. The staves were then coopered out to complete the true circle. When the pipe was round and true and all the staves drawn up tight at the butt-joints, the bands were again cinched up tight and firm. Finally earth was tamped all around the pipe, the pipe was covered up, and the trench refilled.

A pipe laying gang consists of eight to sixteen men. Where the pressure is heavy and the bands are but 2 or 3 in. apart, a larger gang is required than on light-pressure pipe, half the gang being employed on the final cinching and finishing of the pipe in the rear of those who set up the pipe and place the bands. On a long pipe gangs are placed every 1500 ft., and, where gangs working in opposite directions meet, the coupling of the ends is effected by cutting the staves about ⅛ in. longer than the space they are to occupy and springing them in position. The bands, closing tightly together, make the butt-joints at the coupling really tighter than they are ordinarily. Soon after the pipe is laid, water is slowly admitted, and the pipe left to soak it up until the full pressure is on. All minor cracks and leaks will gradually disappear, and serious ones are easily located and stopped. Air valves, blow-off gates, and stand pipes are located where required. Both California redwood and Texas long-leaf pine may be used in the construction.

At the point of connection with the water-wheel with its large iron cups the iron saddle is shown, with a man's face looking out of the hole in it.



THE NOZZLE IN ITS FOUNDATION.



PIPE CONNECTION TO PENSTOCK OF OPEN FLUME—BEFORE BANDING THE PIPE.

Among the advantages claimed for this stave pipe are its cheapness and capacity for great dimensions.

Wood, when buried or water-logged, has often been found wonderfully durable. Old pine log pipes 5 in. in bore laid in 1797 were found sound when dug up in 1870. The old water-logged remains of the ancient lake dwellers, after perhaps thousands of years of immersion, have been dug up in a comparatively sound condition. The bog oak of the Irish swamps, contemporaneous with the mammoth and great elk, is famous for its hardness and preservation.

The interior remains smooth, and the diameter is never decreased by rust incrustations or tubercles. The passage-way is always clean and sweet, and contains no calking yarn or oakum to decay and pollute the water.

The pipe does not burst or break by settlement. It is continuous, with no positive end joints ; it can be laid at a hundred different points at once, and the various sections coupled up without extra cost or delay. It is readily tapped and mended, and can be easily taken up and replaced without strain or injury to any of its parts. It can be built over mountains and comparatively inaccessible regions, as it is composed of pieces that are light and easily handled. It is equally strong throughout, all its joints being broken and the bands spaced to the exact pressure at all points. It is built continuously in the trench where it lies, and not in sections made in the shop ; hence there is no extra handling, loading, or unloading into the trench.

The metal tongues effectually prevent leaking, and the band forms a good joining, obviating the use of oakum.

Though at first used only in long irrigating or city water systems, it is now being applied to various other uses,—particularly as in the case of the Stanley mine, for working machinery in mining. As I write, a pressure pipe is in contemplation for bringing the waters of Clear creek to bear, under powerful pressure, upon giant nozzles for an extensive gold-placer undertaking.

HEATING AND VENTILATING TALL BUILDINGS.

By Leicester Allen.

THE tall office-building has come, and there is little to be gained in protest against it. It represents capital in one of its most arrogant manifestations. There is much profit in erecting and renting such buildings; therefore they will continue to be built. It matters not that no architect has ever yet succeeded in grafting beauty upon disproportion. It is of no consequence that these piles rob lesser buildings of their share of air and light, or that they are offensive to adjacent owners. Nothing matters much nowadays but dollars. Dollars must be gathered in, even if the harvest leaves behind it widely-distributed dolors. It seems to those who have more dolors than dollars that many who are now making large investments in tall buildings ought to rest satisfied without further effort to amass wealth; but money-getting, like dram-drinking, never satisfies the appetite it creates.

The tall building, let us hasten to acknowledge, has some excuse for existing, notwithstanding its esthetic defects. It affords, in many respects, accommodations for offices that never were provided till it came into being. With its rapid-transit elevators, its electric lights, its efficient janitor-service, its broad views from the higher windows, the breezes that cool in summer, the concentration of business it effects, it is attractive enough to entice tenants, and is generally well occupied, notwithstanding two great defects.

The tall building is almost universally badly heated and as badly ventilated, and in these respects it is unsanitary. There are generally heat enough and ventilation enough, but neither is of the right sort. The heating is excessive for mild weather, and the ventilation, only obtainable by opening windows, creates murderous drafts, so that many prefer to keep windows closed rather than take the risks ventilation imposes. In these respects the large majority of tall office-buildings are death-traps, and will so remain till the better methods of heating and ventilating them, now in their infancy, shall become the rule instead of the exception.

An entirely new set of conditions has been introduced by the tall building, which heating and ventilating engineers have attempted to meet by old methods, or mere modifications of old methods, and it is not surprising that they have failed to get desirable results. Have they not failed? I assert that they have. Day by day I spend the hours in one of the best of these buildings. It was designed by one of the foremost architects in America, and its heating-plant was put in by a firm of heating engineers in high repute. Yet I believe there is not an occupant of the building who would consider a dwelling so heated and ventilated fit for his family to live in. A dwelling-house in which the only escape from over-heating when the thermometer outside stands at from 35° to 40° F. is by opening windows would be justly regarded as intolerable by occupants, and it would be a disgrace to both the architect and the engineer who planned it ; yet this, with very few exceptions, is precisely the condition in a large number of rooms in the tall office-buildings hitherto erected. I feel certain I shall not be accused of exaggeration by tenants, however much my statements may be opposed by owners and others interested pecuniarily in the erection and renting of these structures.

On the 29th of March business called me into the office of an architect in one of these buildings. The windows in his drafting-room stood open. His assistants had removed their coats. When I went out of the building, I went immediately to ascertain the outside temperature, and found it only slightly above 40° F. I found the same thing in other offices in similar buildings. The day was windy, and the drafts in these offices would be considered anywhere as sharp and dangerous. I observed that some of the women employed in these offices had endeavored by shawls and kerchiefs to shield themselves somewhat from the drafts. Coughing and sneezing everywhere betrayed the effects of these drafts, yet they were submitted to in the effort to avoid the discomfort of over-heating. In one office I observed a large screen placed between one of the occupants and a window at his back, while he continued work with the aid of an electric light, although the day was bright and sunny. Is it not true, then, as charged, that the heating and ventilation of this class of buildings would, as a rule, be regarded intolerable in dwellings?

Let us glance briefly at the conditions. In the first place the requirements for light in numerous offices in a single building necessitate a large amount of window area. The windows lend themselves kindly to the effort to tone down the unsightliness of the tall building, and so windows with arched tops and other fancy styles are introduced. The sashes do not fit the casements tightly, and every window is therefore a generator of drafts, even when closed as tightly as it can be. I have not yet seen tight windows in one of these buildings. Weather strips may be resorted to, but even these have failed in some instances to prevent sharp drafts in high winds.

It should be remembered that such tall structures are affected by winds far more than those only four or five stories high, even when the latter are isolated. The upper stories of the tall building have no trees or adjacent dwellings to break the force of the winds; and what would appear only as a moderate breeze in the street is a fierce blast fourteen to twenty stories from the ground. It is well known to all heating engineers that the effect of a strong wind is to cool the space in the building near the side which receives the blast, and to drive the interior warmed air through crevices in doors and partitions, and even through the materials of walls and partitions over to the space on the lee side. Thus one part of a house on the same floor may be too cold for comfort, while another, not very remote, may be overheated. This effect is greatly intensified in tall buildings.

A feature of the tall office-building is the great size of its elevator-shafts. Thousands of people must be carried up and down each day. Three large, rapid-running elevators in a single building are common, and as many as six are sometimes used. There is also the continuous passage for stairs up through the entire building. The draft in these shafts is enormous. Every time a lower room is opened, some of its heated air escapes and rises up through these passages. This air is more or less vitiated by occupants of the rooms from which it escapes. The frequent opening of doors in the upper offices admits this warmed and somewhat impaired air, and if, in the effort to regulate heat, the transoms be resorted to, opening these often increases, instead of alleviating, the discomfort. I do not mean to say that these defects do not exist in buildings even five stories high, but I would emphasize the fact that they increase with, and almost in proportion to, the number of stories. They would be almost five times as injurious in a twenty-story building as in one of four stories.

The number of those who go in and out of the tall office-building is very much greater than in a building of moderate height. The entrance-doors during business hours are almost constantly swinging. The inrush of cold air at the bottom is great. As has been already intimated, there is plenty of air admitted in various ways, but the mere admission of a large volume of outside air, and the consequent forcing-out of an equal volume of inside air, while, strictly speaking, a kind of ventilation, is by no means good ventilation.

Now we are near the close of the nineteenth century, the most wonderful for its enrichment of scientific knowledge and mechanical resources in the history of the world; the direct steam radiator with valves operated by hand is generally admitted to be a device for heating rooms which gives the occupant the least facility for regulating heat of any means yet employed for the purpose; yet this is the system which heating engineers have generally employed for heating the tall office-building. The reason this has been so is not that a better system could not be devised, but that owners failed to realize the importance of anything better. Engineers could have found a way to heat tall buildings that would give occupants control of the heat in their offices and also fairly good ventilation, had they been given free scope to apply existing means to the solution of the problem.

But owners have only just begun to realize the importance of better heating and ventilation. Those who have the shrewdness to perceive how much these improvements would enhance the rental value of their investments will find in a very few years that they have left their earlier competitors far in the rear. Were the supply of well-ventilated, comfortably-warmed tall office-buildings ample, those now heated with direct steam radiators fitted with common globe-valves and ventilated only by windows and crevices would soon go begging for tenants.

But the difficulties in doing this can only be overcome by liberal expenditure. No competent heating engineer would shrink from undertaking the heating and ventilation for a mansion, a school, a church, or a hospital. Architects have learned that such buildings must be designed, at least in some measure, with reference to obtaining a proper system of heating and ventilation. But in the tall building all that hitherto has been much considered by architects with reference to heating and ventilation appears to have been the provision of chases on the inside of the masonry wherein the steam-heating contractor may erect his riser pipes. But, unless architects coöperate with engineers as they do in those lesser buildings which offer the best examples of heating and ventilation, the tall building in these particulars will continue to be a monument of stupidity in both these professions.

Ventilation that does not necessitate the use of windows requires ventilating-ducts and -flues. Where is there a place in the tall office-building for these? Certainly not in the outer walls, as at present constructed. Hollow partitions wherein such flues could be placed would solve this part of the problem. These have never been adopted within my knowledge, and they are not likely to be, because they would increase greatly the cost of the structure. They would also necessitate the division of successive floors into rooms, each substantially on the same scheme, since the flues leading from any room must go to the top, or connect with some other flue leading to the top, of the building. This method would also absorb much valuable floor space, and, on the whole, probably would not be consented to by either owner or architect.

A prominent engineer in New York, Mr. Alfred R. Wolff, has utilized the overhead space in corridors for air passages to and from rooms, and has thus succeeded in introducing into the tall building a plenum system of controlled ventilation. The circulation is maintained by ventilating fan-wheels. But, as yet, only a few examples of this system in tall buildings exist. Of these may be mentioned the building of Kuhn Loeb & Co., 27 Pine street, New York (thirteen stories); the Carnegie Office-Building, Pittsburg (fifteen stories); and the Keeler and Kimball Building, Rochester (twelve stories). These are each heated and ventilated in accordance with plans designed by Mr. Wolff, and two others to be similarly heated and ventilated—the New York Life Insurance Company's building on lower Broadway, New York (fourteen stories), and the American Surety Company's building, Broadway and Pine streets, New York (twenty stories)—are now in course of erection. Automatic regulation of radiators by thermostatic control of their valves is also comprised in Mr. Wolff's designs, and these two features are a long step towards remedying the evils complained of. Offices in tall buildings, for the most part, must continue to be heated each by a single direct steam radiator. If supplied with ordinary globe valves, such a radiator, if used at all, must be used nearly at its full capacity. No nice gradation between full capacity and no heat at all is possible with any direct steam radiator whose valves are closed and opened by hand. The use of several direct steam radiators of different capacities in a single room, one or more of which can be used as needed, would approach a controllable system; but this is clearly impossible except in large rooms, or suites of connected rooms in which doorways may stand open. Indirect steam-heating adds to the difficulty of obtaining space for ventilating-flues, and demands greater space for warm-air flues. It is impossible to conceive any practicable method of applying it to tall office-buildings, except by some such scheme as that which Mr. Wolff has adopted. The system must mainly be direct. The problem is thus reduced to finding a direct system, or a combination of direct and indirect systems, of heating that can be regulated, not only as a whole, but in each of its parts.

Electric heating at once suggests itself. Not only can an electric heater be so regulated as to impart to air and surrounding objects any amount of heat,—from nothing to its full capacity,—but it can be made self-regulating to any desired degree of temperature when controlled by a thermostat. Instead of an elaborate system of piping, conductors of small size can be used, which can be run in any direction, and which do not require any modifications of plans to render them practicable. But, as yet, the cost of heating by electricity is too great for such a purpose, and the economy of using exhaust-steam from the elevator pumps and the steam engines that drive the dynamos is so important that any system, to be acceptable, must include this feature.

A system whereby both the exhaust-steam may be used and, at the same time, the desired regulation of heat by occupants may be obtained has been placed in the Criminal Courts Building in New York. This may have been elsewhere employed. I understand it is controlled by a patent. I shall avoid details, since any one familiar with steam and hot-water heating will be able to understand what are the proper appliances for carrying it out in any particular building, and this, or any other system, requires special planning in almost every case.

The system is one of hot-water heating. The circulating pipes which convey water to and from the radiators may be smaller than is required for ordinary hot-water heating, because the circulation is maintained and rendered substantially uniform in all of these pipes by mechanical means. This water returns from any line of radiators back to the cellar of the building at a nearly fixed temperature. Reaching the cellar, it is reheated by the exhaust in a condenser, which ought to have sufficient surface to completely condense the exhaust steam. The water so condensed may be then passed back to the boilers supplying pumps or engines with power, and used over and over in these boilers for power purposes. The water flowing back from the radiators, being thus reheated as much as the exhaust-steam will permit, may next be passed into a special water-heater, wherein it is heated still further to the prescribed initial temperature.

In such a system the radiators should each be provided with a by-pass, the valve in which could be so arranged with reference to the inlet valve of the radiator that, when the latter is closed to any degree, the by-pass valve will be opened to the same extent. In this way every radiator would be entirely independent of each or all of the others, and could be made to circulate just as much or as little of the heated water as desired.

The expenditure of fuel for heating proper is thus confined to that needed to add the final increment of heat to the water used in the system, after it has been passed through the condenser. The expenditure for power would be that necessary for the circulating and condenser pump, which, as the difference in pressure between supply- and return-pipes is small, could not much exceed what is needed to overcome the friction of the water in the pipes.

The current cost for fuel would be thus sometimes increased over that required for power. The increase in the cost of the plant over that now principally used would be the cost of the supplementary hot-water heater and its appurtenances, the surface condenser, and the circulating pump, and the extra cost of the radiators, which would need to have a larger extent of heating surface than steam radiators. If by-passes are used, one extra valve for each radiator will be required. The total increase of cost would, of course, vary with the size of the plant. Suppose that, for a building containing two hundred offices, this increase might be $10,000. Allowing 10 per cent. for deterioration and 6 per cent. interest on the investment, the cost per year of the addition would be $1600, or $8 per tenant. The increase of cost of fuel and attendance would be easily covered by $800, which would make the total $2400, or $12 per tenant. An increase of rent of $1.00 per month for each office would thus pay for making all the tenants comfortable in any sort of weather. I think five times this sum would be gladly paid by most tenants who have experience of the inconvenience and discomfort of steam heat in a tall office-building. The assumed increase of cost is merely guess-work. I have not found opportunity to make a reliable estimate. The scheme is mentioned with the hope that it will lead to a reconsideration of the possibilities of hot-water heating for buildings hitherto supposed to be too high for its application in any form.

But improved heating and ventilation in tall office-buildings cannot be had without increased cost. It would be worth all it is likely to cost. The system of heating in the tall buildings above named, as I am informed, cost twice as much as the common system of direct steam-heating. I have not on that account the slightest doubt of the wisdom of the owners in adopting it. Not insignificant items in the cost are the calculations, preparation of plans, and supervision of the work during erection. The minutest details require careful attention, and in all parts the application of scientific principles and engineering skill is requisite. I predict that the tall office-buildings which are fitted only with the present rude system of direct steam-heating will in a few years find themselves sadly handicapped in competition with those that have adopted improved methods.

THE ADVANCES IN MODERN IRON-SMELTING.

By John Birkinbine.

THE United States is a new country compared with nations whose histories are traced for thousands of years, and all of its industries may therefore be classed as modern. But, according to the American gage, the production of pig iron is among our ancient industries, for authentic records give the date of the initial blast-furnace in the United States as 1645, with a possibility that some preceding works were furnaces and not forges.

In this paper the blast-furnace only will be considered, omitting reference to the forge or other processes by which ore was converted into iron ; and the smelting of iron ores in the United States only can be given consideration, the limit of space permitting but a hasty *résumé* of the advances made in this country.

For two centuries this industry did little more than spread over a more extended area, its growth being an increase in the number of blast-furnaces, and its development chiefly an occupation of new territory. Masses of masonry inclosing the hearth, boshes, and inwalls of the blast-furnaces retained the original form, and gradually assumed larger proportions, but the changes in arrangement and in practice were slight. To deliver heavier charges of ore, flux, and fuel, hand-barrows traversing a bridge-house extending from a bank to the top of the furnace displaced to a considerable extent the baskets and boxes formerly carried upon the heads or in the arms of laborers, who ascended ladders leading to the tunnel-head ; and other details were similarly improved. But for almost two centuries an American blast-furnace could be described as a stone stack seldom exceeding 30 ft. in height, into which iron ore, flux, and charcoal were fed, blast at atmospheric temperature being supplied by large wooden or leathern bellows operated by a water-wheel. Blowing cylinders made of wooden staves bound with iron bands were also used, and, later, iron cylinders gave greater blowing capacity to somewhat larger furnaces producing more pig iron. However, an average weekly product of 25 tons of pig iron and a continuous campaign exceeding 40 weeks were unusual, an output of 1000 tons of metal per annum being considerably above the average obtained from then existing plants.

About 1840 a combination of advances, among which were the construction of railroads, the application of steam to operate blast machinery, the introduction of the hot-blast stove to heat the air driven into the furnace, and the use of mineral fuel, brought about changes in furnace construction, equipment, operation, and location; but up to 1850 a furnace stack which produced 2500 tons of pig iron annually would "claim the broom." The ample supply of mineral fuel and the possibility of assembling any desired quantities of coal or iron ore by railroad permitted furnaces of larger capacity to be erected at locations which had previously been undesirable, but which had other advantages. The improvement in tools and mechanical skill produced blowing machinery of greater power, and the use of heated air resulted in larger outputs from a given furnace, and reduced fuel consumption per ton of iron made.

Notwithstanding these important improvements, few American blast-furnaces had in any one year up to 1875 produced 10,000 tons of pig iron,—an amount certainly much in excess of what was obtained a quarter of a century before, but only about one-tenth of what is at the present time considered remarkable work.

The increase in size of blast-furnaces is well illustrated in Plate I, which shows the interior dimensions of three stacks: (a) charcoal furnace 35 ft. high, with a bosh diameter of 10 ft., and a capacity of 1225 cubic ft., which up to 1840 would have been reckoned as a large furnace; (b) an anthracite furnace built in 1875, which, although not the largest, surpassed in its dimensions the average of stacks then active; it was 55 ft. high, with a bosh diameter of 16 ft. and a capacity of 5250 cu. ft.; (c) a coke furnace erected in 1892, which has won renown as a producer of large quantities of pig iron; it is 91 ft. 4 in. high, 20 ft. in diameter at the bosh, and has a capacity of 18,200 cu. ft. It is larger than the average furnace now on the active list, but there are a score of American stacks which approximate the dimensions shown.

The changes from the small to the large crucible, the increased height, and the greatly augmented capacity are evident from an inspection of the plate.

The past two decades, or at least the last quarter of a century, show the true progress in pig-iron production, and represent an advance far in excess of what had been achieved in the entire previous history of the iron industry in this country, and fully as great as that achieved during a similar interval in foreign lands.

American blast-furnace managers are indebted to European specialists for much of the research into the theory of iron-smelting, but in no part of the world has this theoretical knowledge been applied with better result than in the United States, and the productive capacity of the furnaces of this country is a source of astonishment to metallurgists throughout the world.

The chemistry of iron-smelting cannot be said to have been appreciated until after 1870, and the formation of such organizations as the American Institute of Mining Engineers, encouraging interchange of data among blast-furnace managers, resulted in breaking down traditions and establishing a fraternity of mutual helpfulness. As the theory of iron production was investigated, the true functions of the blast-furnace were realized, and, as a result, larger outputs were obtained with greatly reduced consumption of fuel per ton of iron.

In the older practice the mineral most accessible, or that which yielded iron most readily, was employed, and, although attention was given to quality, it was mainly applied to considering iron ores which produced "red short" or "cold short" iron, or to mixing them in suitable proportions when "neutral" pig metal was sought for. The chemist's function was to determine *how* certain elements influenced the quality of iron, and his work has grown in importance until at present he is practically dictator at the blast-furnace. But without the engineer to design blast-furnace structures and machinery, and the manager to intelligently direct the operations, the chemist's investigations would not have made possible the remarkable practice of the present time.

Accustomed to judge of pig iron solely by its fracture and grain, or by its behavior when cast or wrought, the blast-furnace manager naturally viewed with suspicion the assertion that small fractions of 1 per cent. of some elements would fit or unfit an iron for specific uses; and to-day few persons realize that in laboratories connected with blast-furnaces it is necessary to carry the determinations to a degree of nicety unknown even in the assaying of the precious metals. It is, therefore, unjust to apply the term "old fogy" to men who, having by persistent effort utilized the limit of their knowledge to advantage, were slow to grasp the new order of things which the chemist proposed.

Appreciation of the theory of iron-smelting, and of the possibilities of the blast-furnace, caused more powerful machinery to be designed to furnish blast to furnace-stacks of greater dimensions; and one of the advance steps was the enlargement of the crucible, as the managers recognized that the quantity of fuel properly burned in a given time determined the producing capacity of a furnace. Another step was to secure better utilization of fuel by increasing the temperature of the air blown, and by selecting ores which yielded iron liberally, or which demanded a small percentage of flux. As the problem of fluxing became better understood, the importance of employing fuel with a minimum amount of ash and of elements injurious to the iron made was also appreciated.

Instead of discussing results at specific furnaces or in certain districts, it may be well to glance at the progress which this country has made in the quantity of pig iron produced, and to note how this progress compares with that of some other countries in which the iron industry is of importance. The first reliable record of pig-iron manufacture in the United States shows a production in 1810 of 53,908 gross tons, the nearest contemporaneous data being for England in 1806,—243,851 gross tons,—and France in 1819,—112,000 metric tons.

In 1830 the United States is credited with 165,000 gross tons, England with 678,417 gross tons, and France with 266,000 metric tons.

In 1875 the United States produced 2,023,733 gross tons, England 6,365,462 gross tons, France 1,448,000 metric tons, Germany 2,029,389 metric tons, and Belgium 541,790 metric tons.

In 1892 the United States produced 9,157,000 gross tons, England 6,709,255 gross tons, France 2,057,258 metric tons, Germany 4,937,461 metric tons, and Belgium 753,790 metric tons.

Since 1854 the American Iron and Steel Association has collected and published accurate pig-iron statistics for the United States, and similar data are obtainable for nearly the same period for other countries; and, to illustrate the rapid strides made in the United States, and also the relation which this country bears to others which are important contributors to the world's output of this metal, the accompanying diagram has been prepared. It shows the quantities of pig iron made during the past 25 years in the United States, Great Britain, Germany (including the Grand Duchy of Luxemburg), and France, for as many of the years as authentic records are obtainable for in each case. The diagram needs no comment, for it represents the contemporaneous position of each of the countries named, and emphasizes the steps by which the United States have advanced to their prespresent position.

The story which it and the earlier statistics quoted tells is that a single blast-furnace of the average size of those now being constructed produces as much pig iron in a year as the entire output of the United States in 1810, and that two of the larger modern stacks can supply more metal annually than the country made in 1830. Approaching nearer to the present, a comparison may be found in the statement that in 1894 the 26 blast-furnaces in the vicinity of Pittsburg produced 1,782,079 gross tons of pig iron, which is about 90 per cent. of the total output credited to the nation in 1875, when there were 713 stacks reported in operation or in condition for work; and probably 350 of these stacks helped to make the total for 1875.

The history of pig-iron manufacture in the United States may, therefore, be considered as divided into three parts.

First. From 1645 to about 1840, when charcoal was the only fuel used: the furnaces, being deficient in power and supplied with cold blast, were restricted in size, and the consumption of fuel per ton of iron made ranged between 3000 and 5000 lbs. of charcoal. During that period the increased production was mainly the result of multiplying the number of furnaces, the difficulty of transportation restricting their location within convenient distances of a market for the product, and close to water power, woodlands, and ore mines. The furnace stacks were truncated pyramids of massive stone masonry, and from the tunnel-heads flames were constantly rising when the furnaces were in operation. Cinder flowed continually over the dam, while the molten iron accumulated in a fore hearth, from which it was tapped twice daily, or ladled out to form castings.

Second. From about 1840 to about 1870 the improvements in machine tools and the advance of steam engineering resulted in providing blowing machinery capable of operating larger furnaces, although many water-wheels were retained as power. The gases resulting from the furnace operation were utilized as fuel for boilers and to heat the blast in iron-pipe stoves; and bells fitting against hoppers in the furnace tunnel-heads gave control over these gases, and distributed the ore, fuel, and flux fed into the wider throats. Anthracite coal and bituminous coal, and coke made from the latter, were applied as blast-furnace fuels, and about 1854 the quantity of pig iron produced with mineral fuel exceeded that made with charcoal; after that date anthracite coal was the principal blast-furnace fuel for 20 years.

The stack structures passed through numerous changes in form, the present familiar type of an iron casing surrounding the furnace masonry and resting on iron columns being evolved from the massive stone stack through various modifications, in which brick displaced stone and iron supplanted brick. (It is of interest to note that the ground-spaces occupied by the stacks of the three furnaces illustrated on Plate 1 were practically the same.) The sandstone hearths and shale inwalls were displaced by linings of fire-brick, and the open tuyere and fore hearth were supplemented by closed tuyeres, tymp, and dam, all protected by water-cooling appliances.

With the introduction of steam, pneumatic, or water-balanced vertical hoists or inclined planes, it was not necessary to seek a location by the side of a bank level with the tunnel-head; and the increased transportation facilities by railroad and canal permitted the selection of sites where the raw materials could be conveniently assembled and the product readily carried to market.

This interval was characterized by enlarged furnaces, which supplied greater quantities of pig iron, and also by an increased number of stacks; but, beyond the economy due to heated blast, there was no marked decrease in the quantity of fuel necessary to produce a ton of metal, the range being 2500 to 4000 lbs. From 1854 the quantity of pig iron made with anthracite coal was in excess of that made with bituminous coal and coke, but since 1875 the quantity of iron produced by the latter has been in advance of the output of the anthracite furnaces. Numerous modifications, due to the quantities of raw materials, pig iron, and cinder handled, were introduced, among them being intermittent cinder flushing, casting at shorter intervals, the use of charging scales, and receiving trestles for raw stock.

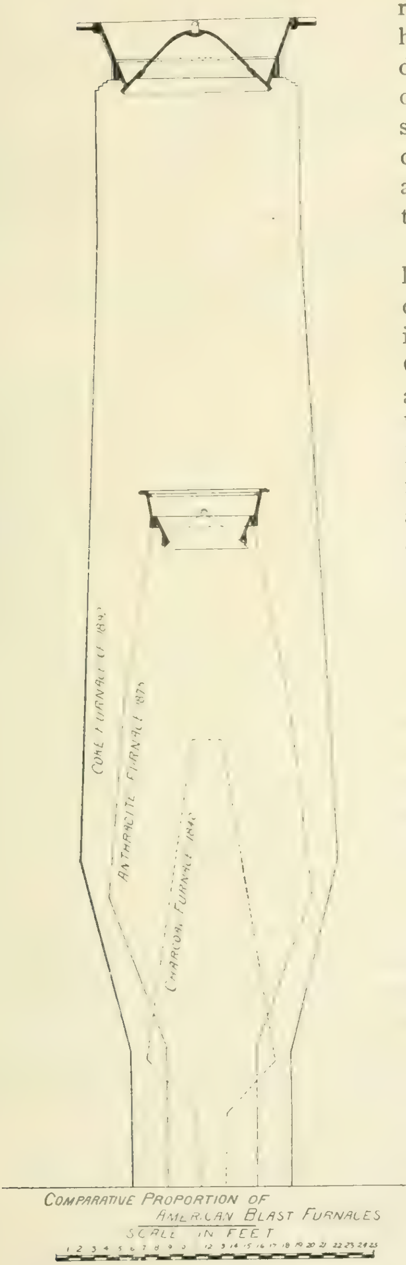
Third. Subsequent to 1870 came the radical development in blast-furnace practice, in which further increase in furnace dimensions was attained, still more powerful blowing machinery erected, and practice based upon a knowledge of the smelting process followed. The massive walls of fire-brick which prevented holding the furnace to an approximate interior shape desired were reduced in thickness and protected by water blocks, bosh coils and plates, crucible jackets, etc., so that now the quantity of fire-brick used to line the large coke furnace shown is probably no greater than was required for the smaller anthracite furnace on Plate 1. Iron-pipe hot-blast stoves were improved, and the regenerative fire-brick stove introduced, so that temperatures of 1200° and 1400° F. are employed in place of those ranging from 600° to 900°.

With larger crucibles supplied with highly-heated air under higher pressure, and the augmented space for reduction, greater quantities of iron are produced, demanding more frequent iron casts and cinder flushes,—the latter, and in some instances the former, being removed in a molten state in special ladle cars hauled by locomotives.

The chemist now analyzes the ores, fuel, and flux supplied to the furnace, as well as the iron, cinder, and gases which come from it, and the manager, with the knowledge of their composition to supplement his watchfulness of detail, is able not only to obtain increased output, but to furnish metal of a desired composition, the percentages of silicon, sulphur, phosphorus, manganese, and carbon being maintained within such narrow limits as to cause surprise to those who do not recognize the possibilities of blast-furnace practice.

With this increased yield and better control has come a marked decrease of fuel consumption, and the furnace which now requires the minimum amount credited to 1875 (2500 lbs.) is considered as working at a disadvantage, while records of 1750, 1800, and 1900 lbs. of coke used per ton of pig iron made are necessary to win praise at the present time.

The locomotive now takes the place of the horse or mule, and the



COMPARATIVE PROPORTION OF AMERICAN BLAST FURNACES

rock-breaker supplants the mine-hammer at blast-furnaces. The demand for iron of specific quality has necessitated careful selection and preparation of ores, fuel, and flux, and materials are now carried over long distances to blast-furnaces.

The three districts which have shown the greatest development in pig-iron manufacture in late years have Pittsburg, Chicago, and Birmingham, Ala., as their business centers. The bulk of the ore-supply for the Pittsburg district is brought from mines in Minnesota, Wisconsin, and Michigan to meet the local coke. The furnaces in the vicinity of Chicago also draw their ore from the Lake Superior district, the coke coming from Pennsylvania and West Virginia. Ore and coking coal abound in the Birmingham district, where iron is produced at low cost, but the metal made finds its greatest market in the States north of the Ohio and Potomac rivers. The assembling of raw materials from points so widely separated, or the carriage of iron made to distant markets, is only possible because of the economies introduced in blast-furnace operation.

The rapid growth of pig-iron production in the United States indicated on Plate II was not, as in previous divisions, due to an increased number of furnaces, for statistics show a nearly constant decrease in the number of stacks, the augmented output coming from furnaces of larger average proportions and from improved practice. The number of blast-furnace stacks in existence at any time is subject to discount on account of plants being abandoned, destroyed, or out of repair, but fairly accurate comparisons can be made from the record of the number in blast at the end of each year. The following will indicate how the output per furnace has increased, the two columns showing the number of furnaces in blast in the United States at the close of the years stated and the total quantity of pig iron made during the year, as reported by the American Iron and Steel Association.

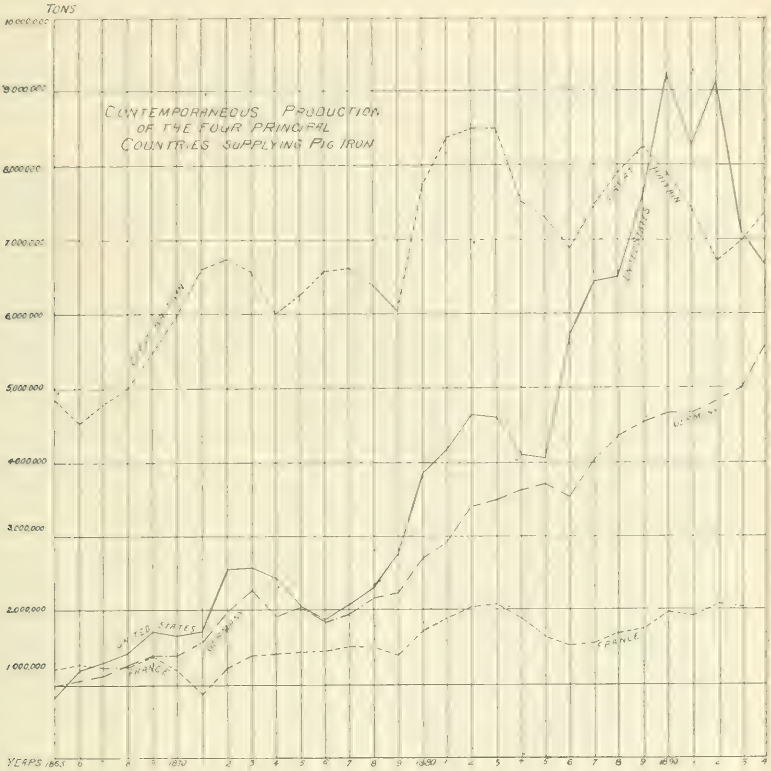
COMPARISON OF THE NUMBER OF FURNACES IN BLAST AT THE END OF EACH YEAR, AND TOTAL PRODUCTION OF PIG IRON IN THE UNITED STATES. 1873-1894.

Years.	Number furnaces in blast Dec. 31.	Production. Gross tons	Years.	Number furnaces in blast Dec. 31.	Production. Gross tons.
1873	410	2,560,963	1884	236	4,097,868
1874	365	2,401,262	1885	276	4,044,526
1875	293	2.023.733	1886	331	5.683.329
1876	236	1,868,961	1887	339	6,417,148
1877	270	2,066,594	1888	332	6.489,738
1878	265	2,301,215	1889	344	7,603,642
1879	388	2,741.853	1890	311	9,202,703
1880	446	3.835.191	1891	313	8,279,870
1881	455	4,144,254	1892	253	9,157,000
1882	417	4.623.323	1893	137	7,124,502
1883	307	4.595.510	1894	185	6,657,388

Comparisons based on this table will not be absolute, for the condition of blast-furnaces during each year is not reported; thus, towards the close of 1893, the production of pig iron rapidly fell off, and furnaces were blown out, while in 1894 the reverse occurred, the amount of metal increasing towards the close of the year. But the table indicates how great the advances have been, and this can be appreciated by considering that the mean between the figures for two successive years represents the average number of furnaces in blast during the year.

On this basis the table shows that the practice of 1880 was so much above that of 1873 that, with an apparent increase of but seven furnaces, the production was augmented 50 per cent.; similar comparisons indicate that, with a nearly equal number of furnaces reported in blast, the output for 1876 was more than doubled in 1884. This continuous growth in output is especially emphasized from the records of 1875, 1879, and 1892,—the latter year, with a smaller number of furnaces, having more than quadrupled the product of 1875.

Improved blast-furnace practice has, by augmented outputs and by reduction of the quantity of fuel, ore, and flux required per ton of pig iron, demanded less labor, and smaller amounts for repairs, fixed charges, etc., per ton of product: and this advance is well illustrated



in the declining selling prices of pig iron: for, as lower quotations cannot be met except by cheapening production, they really represent a progressive tendency as long as the reductions leave a fair return for labor and capital. From a statistical chart, prepared by Mr. Wm. G. Neilson, of the average price of pig iron from 1799 to 1844, supplemented by subsequent data collated by Mr. Jas. M. Swank, it appears that in 1799 charcoal pig iron was sold for $36.25 per gross ton in Philadelphia, and that the price, after various oscillations, had fallen to $32.75 in 1840. The statistics show that the price of No. 1 anthracite pig iron at Philadelphia was $25.75 per ton in 1844, rose during the war, then fell, and in 1875 averaged $25.50 per ton; while in 1890 it stood at $18.40, and in 1892 at $15.75, per ton. In the present depressed state of the iron market, prices have fallen still lower, the average in 1894 being but $12.66,—a rate evidently below that which indicates true progress.

The latter features of this decline will appear from the following *résumé* of average monthly quotations:

	January, 1892.	January, 1893	January. 1894.	January, 1895
No, 1 Anthracite pig iron at Phila.....	$17.50	$14.80	$13.37	$12.08
Grey forge pig iron at Phila...........	14.25	13.10	11.56	10.50
Grey forge pig iron at Pittsburg.......	13.50	12.30	9.88	9.17
Bessemer pig iron at Pittsburg........	15.65	12.59	10.90	10.06

It has been possible only to summarize the prominent features of progress made, leaving many interesting details unnoticed ; but this article would be incomplete if it failed to state that the results attained in iron-smelting have been made possible by advances even more pronounced in processes for converting the pig iron into manufactured forms, many of the researches into the chemistry of iron-smelting having resulted from the demands of steel and iron works for metal of special quality in large quantity. The marvellous changes in blast-furnace practice, the increased output per furnace, the low fuel consumption per ton of product, the restricted limit of composition attained, and the reduction in labor offer an excellent example of what can be expected in other branches of industry where technical investigation is supplemented by business methods and boldness of effort.

The proud record which has been but partially set forth in these pages represents close study, hard work, and liberal expenditure of money, and its history would embrace many failures and many discouragements. But the end is not yet ; there are other investigations to be made, other difficulties to be overcome, and one cannot claim to speak prophetically who asserts that there are to be many more "advances in modern iron-smelting."

HINTS FOR THE MECHANIC AND EMPLOYER.

By Edwin Woodward.

INCIDENTALLY it is asserted that every one is adapted for some purpose. Nominally, this is undoubtedly true. But, while one man may be famed for his achievements in learning, another—perhaps his brother—may be noted for his development in cunning and depravity. There is nothing sensational in this statement; the occurrence is so common as to excite but little comment. However, it leads the thinker to ponder a little, and the question arises: Were these brothers born with opposite traits preponderating, and instinctively cropping out as years developed; or with similar characteristics has dissimilar training wrought the change? The question may never be answered satisfactorily. Still, every observer may have seen the winning child develop into the detestable man. No doubt he has also seen the ill-natured boy, by some marvelous transformation, become the kindliest companion. This would indicate that some force beside nature has influence in the matter. This marked difference in one family is suggestive. But, leaving the household, and taking humanity at large, there are an infinite number of individuals of all grades, running from the lowest up. It is not so difficult to perceive the use of the characters ranging from the middle up,—especially as they go up. Many good people cannot see the need of the individuals at the top,—those who cannot comprehend ordinary affairs of life, but can explain a theory with wonderful intuition. It goes without saying that the regard of these parties is mutual.

It is safe to assume that those of the lower scale are not wholly bad. In fact, one of the most dissolute characters known to the writer frequently exhibits evidence that the good is not all submerged. But the mis-spent lives of such persons are unerring guide-boards: Turn aside.

Between these two extremes and somewhere above the middle are a vast number of men—of all trades, no doubt, as well as professions, but surely among machinists and steam engineers—who are not successful, and the reasons are as various as their characteristics.

Many have noted the fact that, while a man may have very indifferent success in his trade, he may exhibit much shrewdness in other matters. This indicates either utter incapacity in that branch or a lack of earnest application,—generally the latter. The object in view, in the latter case, is to concentrate more of the energies on the labor; application is everything, if the ability is not wanting. But, if the ability is not at hand, then there is prudence in forsaking this trade, no matter how congenial, and taking up some other occupation that will afford a possibility of success. In apprentice life this should not be done without careful inquiry. The youth himself is not a competent judge ; the parents or guardians should look into the case, and the foreman may be able to give valuable information, if asked. If he is the right man in the right place, he will take especial note of the boy, if so requested.

These matters should be decided at an early stage, and, if the first choice is right, so much the better ; indeed, it is very much the better, as a dangerous proclivity, an aimless shifting from one thing to another, is avoided. For the man in middle life there is not much to hope from such a change, unless he be more than ordinarily endowed with an aptitude for the new vocation.

Generally speaking, every one is arbiter of himself ; success or failure lies within his own hands. Admitting the fact that outside causes largely influence matters, the fact still remains that these causes may be utilized, if for, or subdued, if against.

It may be repeated that to be successful requires something more than ordinary application. The outlines may be grasped by a comprehensive mind at a glance, but, as small matters constitute the great, so with the conception of the details goes the ultimate success. The young engineer readily masters the rudimentary principles of his trade. He knows that steam is produced by boiling water, and that safety depends on keeping the water-supply above the tubes ; or, if he has never observed the relative height of the tubes and gage cocks, that there must, at least, be one gage of water. He learns, too, that steam must be admitted to the cylinder by the valve as the crank is passing the centre, and, further, that a liberal supply of coal will keep the steam up and a generous allowance of oil will keep things from heating, unless he happens to key the straps on the connection a little too tight, or screw down the journal caps too much ; and then, if he has never given these things thought, he has ample time, before he gets the bearings running as nicely as before. But, if he were asked how much steam the boiler can safely carry, the fact would become patent at once that the figuring of the safe working pressure, or the data necessary for such figuring,—the strength of materials, stays, bracings, riveting, and details,—are matters of which he entertains extremely vague notions.

The same dense ignorance would be manifested, were he approached on the subject of the trimmings or adjuncts, the safety-valve, steam-gage, injector, and other parts. There is the same happy-go-lucky carelessness about the engine : set of the valve, lead-lap-compression, cushion angular advance—clearance, angularity of rods, point of cut-off, and hundreds of other important things are neglected. This evidently is not the way to become a successful engineer in these exacting times. When anything goes wrong in the plant and the engineer in charge is not competent to right it, his time is up, if some one can be found capable of succeeding where he has failed. This should be an incentive to earnest study, which, coupled with practical experience, is the surest guarantee.

The same indifference to details observed in the engineers is also found in the machinist. He can select the proper lathe tool for iron, steel, or brass; knows the height to set it in order to cut best; can prevent chattering by a coarser or finer feed or a little more or less clearance; and is familiar with other points in every-day labor. But, if gears are to be arranged to cut a thread not shown by the index, the effort will require about half a pound of chalk, innumerable figures, and plenty of time, with no certainty of a satisfactory result. Width of key-ways extremely doubtful, pitch of threads the same, but "can easily find out by looking at the figures on the taps."

These things do not give the apprentice independence or decision; lacking either, he lacks much.

It is believed that everyone has, at times, a desire to get on with his work in a more thorough manner, and he resolves to seek further light. The impulse to resume his former study often springs up, and, if the proper encouragement is given at this moment, a happy result follows. Unfortunately the encouragement is not often given. Failures are not confined to those who cannot learn; many having a thorough knowledge of their business do not succeed. A knowledge of other things beside business is necessary. Honesty, integrity, business courtesy, and a host of moral virtues are essentials.

Then, too, it depends much on where one starts in for himself. Sometimes home is the place; more often it is not. Because a man has never made any special mark in his youth, a doubt is ever present as to his real knowledge. It is to be hoped that the writer will not be charged with advocating a tramping life, but certain it is that evil results often follow an attempt to build up a reputation in one's old home. The fact that one has, as yet, made no especial mark is, to most people of his acquaintance, evidence of incapacity. This conception of his ability prevents a recognition of his true worth,—often precludes any active proof of it.

The usual means of keeping him down are employed, prompted sometimes by doubt, sometimes by envy, till eventually the level of the average is the height of his ambition, and thus he merges from the man into the machine.

Very different is the result if his genius is permitted scope—as is usually the case among people unknown; their faith in him may be borne out by works, which alone bear testimony, either for or against.

Nothing is more true than the old edict: "A prophet has no honor in his own country"; for it is often noted that a stranger is given places of responsibility that could be filled better by some of our fellow-workmen.

Every one has observed that those quickest to learn do not always make the best mechanics. In fact, they seldom do. There seems to be a sort of fatality that the brightest learners are seldom able to shake off. It is the belief in their own ability to come out first. This is the natural result of early and easy success. Were the foreman wise, he would not flatter such a one. Rapid progress deludes the worker, and soon he thinks effort on his part unnecessary; when this opinion becomes deep-rooted, material progress ends. Two words from the foreman or employer at the right place work wonders,—one to check inordinate vanity, one to cheer despondency. Success is not a birth right; it is the fruit of labor. However, a fortunate train of circumstances may add largely to the degree of it. Many a young man is handicapped in the very beginning of his career by some unfortunate personal peculiarity. A "frank, open countenance," "an intelligent look," influences many people who know no other way to judge. Their general verdict in the case of those less favored is usually less gratifying. A gradual change is taking place in this respect, however,—due to the fact that customers leave orders at the office, and a competent workman is selected irrespective of his beauty.

It is frequently noted that a young man of a free, ingenuous, and hearty nature, from the very charm of his obliging disposition, seems the personification of success. No matter how unpleasant the task, it is taken in hand with the same cheerfulness that he displays when the work is especially agreeable. No matter how lavish of favors the foreman may be to him, he exhibits no disposition to exult over his less fortunate companions. For these reasons, while they may envy his "good luck," as they term it, it stirs up no vindictive feeling. Thus, one medium of success is cheerful good humor. There is another characteristic often seen, which every one desiring to get on well should be careful to avoid. It is that mean, cringing, fawning disposition that would seek to win favor by deprecating its own worth, or by attributing merits not possessed to those in charge over him.

A marked contrast to this is the sturdy independent nature that does duty, because it is duty; that does not care a rap for the foreman or any one else, so long as duty is conscientiously done. It is he that never courts any one's favor, is utterly indifferent to praise, and holds flattery in contempt. It is often difficult to decide which is uppermost in the foreman's mind,—vexation at his indifference, or admiration for his independence; the latter eventually triumphs.

Follow the life of a boy from his school-days up. The youth with sleepy looks usually is very quiet, very awkward, and, as a rule, not much given to the sports which constitute the chief delight of his companions. He has consequently nothing in common with them. The boy observes this, feels hurt, and by repeated neglect becomes very sensitive, and thinks he is not treated as others are, when in truth he is as derelict as they. Having no other resource, he applies himself to his books, and usually makes more rapid progress than the rest. Eventually the indifference with which he is treated merges into respect, and this, coupled with acknowledged merit, would insure success, if some other boy did not happen to possess all of these and, in addition, that inexplicable something which attracts the good-will and esteem of every one, called personal magnetism. Parents are to a great extent responsible for the want of this characteristic.

The most indifferent may be taught to see that social intimacy between companions is productive of pleasure as well as mutual benefit; and, if the child is not endowed by nature with sociability, constant endeavor may stimulate the dormant faculties, and eventually make him one of the most agreeable and magnetic of men, just as earnest and faithful labor will make the best machinist or engineer from the most backward apprentice.

Many a man has mastered his trade—as it is said—and never perceived this truth,—plodding on, more soured by each new joke of which he is made the victim, becoming more despondent when some new abuse is heaped upon him, not knowing that by taking these and returning them he could work his own salvation. The case of a certain engineer in a large shop is brought to mind, as an illustration of this phase of life. He was faithful to his duties and employers, and in point of qualifications was no better or worse than the average. It did not take the boys long to discover that the poor fellow could not parry a joke or resent an abuse; as soon as one boy had fired his last shot, another would open his battery. He believed the boys when they told him he was to be discharged, and, thinking their talk reflected the sentiments of his employers, he gave up his job in fear of such a result. A little self-reliance would have tided him over.

There are other by-ways of failure and success. Another engineer is noted as overcoming difficulties. His start was a bad one, not only from a lack of theoretical and practical knowledge, but also from a lack of skill. All this was in a measure overcome, and in reality he may be classed as an ordinary engineer, conscientious and careful. These two qualities, supported by public approval, are a trio invincible, and the secret of the latter is judicious diplomacy—nothing else.

How much is the foreman responsible for in the failure or success of his men? More than he is aware of, perhaps. It is his duty to study those under his care. Good will is beneficial, confidence helpful. Mutual esteem is the key of success. These are secured in various ways. It is said that an Irishman is vulnerable only to a joke, an Englishman or German to stiff-necked superiority, while an American approves of nothing but equality. Without doubt the joke has its place sometimes. It is manifestly true that certain men do not recognize any authority that is not tinged with dogmatic arrogance. While these aids may be judiciously used on occasion, they should not be adopted as a regular method of exercising influence.

No one who has not made it a study has any idea of the great number of first-class men occupying subordinate positions from feelings of sentiment or affection. It is quite impossible to induce a workman to acknowledge that such is the fact, but it is none the less true that scores of engineers and machinists are constantly refusing positions manifestly to their advantage, through no other motive. Family and social ties are minded. Unfortunately a certain class of people cannot appreciate such motives. But another and better class can and do. These tend to defeat the ascendency of any one whom these motives govern, and the loss is not his alone, or that of his prospective employer. The world at large suffers, for who will say that a character so admirable would not make an excellent chief engineer or foreman, and, by the display of the kindly traits with which he is so lavishly endowed, tend to elevate all with whom he comes in contact?

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

INTRODUCTORY.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

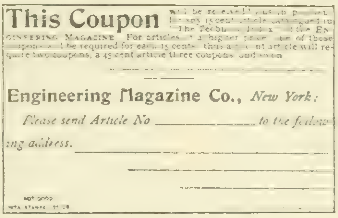
We hold ourselves ready to supply—usually by return mail—the full text of every article reviewed or indexed, and our charge in each case is regulated closely by the cost of a single copy of the journal from which the article is taken.

☞ The price of a single article is ordinarily 15c.; those indicated by an asterisk (*) 30c.; by a dagger (†) 45c.; and above this, the price is given just after the number. In ordering from us care should be taken to *give the number* of the article desired, not the title alone.

The entire Review is conveniently classified into the recognized divisions of applied science—everything pertaining to "Architecture and Building" appearing under that heading, while "Civil Engineering" is given under that title, and so on alphabetically throughout. The titles and addresses of all the journals reviewed are given below, and in the body of the Index the titles are abbreviated—foreign journals in italics. Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell coupons—represented here in miniature.

The price of these coupons is 15c. each, or fifteen for $2, forty for $5, and one hundred for $12.



This Coupon [illegible] any 15 cent article [illegible] The Technical Index [illegible] Engineering Magazine. For articles [illegible] higher price [illegible] of these coupons [illegible] be required for each 15 cents [illegible] article will require two coupons, a 45 cent article three coupons and so on.

Engineering Magazine Co., *New York:*

Please send Article No __________ *to the following address.*

Simply fill in the number, and your address. A stamped envelope does the rest. No letter-writing is required.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their great convenience and economy.

THE PUBLICATIONS REGULARLY REVIEWED.

Arena. *m.* $5. Boston.
American Architect. *w.* $6. Boston.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
American Analyst. *f.* $1. New York.
Architecture and Building. *w.* $6. N. Y.
Arch. Build. and Dec. *m.* $2. Minneapolis.
Am. Chem. Journal. *b-m.* $4. Baltimore.
Asso. of Eng. of Cornell Univ. 1894. Ithaca.
Am. Eng. and Railroad Journal. *m.* $3. N. Y.
Am. Geologist. *m.* $3.50. Minneapolis.
Am. Gas Light Journal. *w.* $3. New York.
Am. Jour. of Science. *m.* $6. New Haven.
Architect, The. *w.* 26*s.* London.
American Machinist. *w.* $3. New York.
Amer. Mag. of Civics. *m.* $3. New York.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. N. Y.
Am. Man. and Iron World. $4. Pittsburg.
Aust. Mining Standard. *w.* 30*s.* Sydney.
Architectural Record. *q.* $1. New York.
Archæologist, The. *m.* $1. Columbus, O.
Architectural Review. *s-q.* $5. Boston.
Age of Steel. *w.* $3. St. Louis.
Amer. Soc. of Irri. Eng. *qr.* $4. Denver.
Am. Soc. of Mec. Eng. *m.* New York.
Builder, The. *w.* 26*s.* London.
British Architect, The. *w.* 23*s.* 8*d.* London.
Brick Builder. *m.* $2.50. Boston.
Bul. Am. Geog. Soc. *q.* $5. N. Y.
Bul. Am. Iron and St. Asso. *w.* $4. Phila.
Boston Jour. of Commerce. *w.* $3. Boston.
Banker's Mag. *m.* $5. N. Y.
Banker's Mag. *m.* 18*s.* London.
Bankers Mag. of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Bul. of the Univ. of Wisconsin.
Calif. Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Colliery Engineer. *m.* $2. Scranton, Pa.
Canadian Engineer. *m.* $1. Montreal.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Chautauquan. *m.* $2. Meadville, Pa.
Century Magazine. *m.* $4. New York.
Canadian Mining Rev. *m.* $1.50. Ottawa.
Commerce. *w.* 36*s.* London.
Cosmopolitan. *m.* $1.50. New York.
Contemporary Review. *m.* $4.50. London.
Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
Domestic Engineering. *m.* $2. Chicago.
Engineering. *w.* 36*s.* London.

Electrical Age. *w.* $3. New York.
Engineer & Contractor. *w.* $1. San Francisco.
Eng. Asso of the South. *m.* $3. Nashville.
Electrical Engineering. *m.* $1. Chicago.
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York.
Electrical Industries. *m.* $1. Chicago.
Electricity. *w.* 7*s.* 6*d.* London.
Electrician. *w.* 24*s.* London.
Engineering Mechanics. *m.* $2. Phila.
Engineering Magazine. *m.* $3. New York
Eng. and Mining Journal. *w.* $5. N. Y
Engineering News. *w.* $5. New York.
Engineer. *s-m.* $2.50. New York.
Engineer. *w.* 36*s.* London.
Electricity. *w.* $2.50. New York.
Electrical Plant. *m.* 6*s.* London.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Eng. So. of W. Pa. Proc *m.* $7. Pittsburg.
Electrical World. *w.* $3. New York.
Forum. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Fortnightly Review. *m.* $4.50. London.
Fire and Water. *w.* $3. New York.
Fairplay. *w.* 32*s.* 6*d.* London.
Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
Garden and Forest. *w.* $4. New York.
Geol. Mag., The. *m.* 18s. London.
Gas World. *w.* 13*s.* London.
Heating and Ventilation. *m.* $1. N. Y.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Indian Engineering. *w.* 18 Rs. Calcutta.
Indian Engineer. *w.* 20 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Iron & Steel Trades' Jour. *w.* 25*s.* London.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
Iron Ind. Gazette. *m.* $1.50. Buffalo.
Invention. *w.* 11*s.* London.
Iron Age. *w.* $4.50. New York.
India Rubber World. *m.* $3. New York.
Industry. *m.* $2. San Francisco.
Iron Trade Review. *w.* $3. Cleveland
Jour. Am. Chem. So. *m.* $5. Easton.
Jour. Assoc. Eng. Soc. *m.* $3. St. Louis.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Jour. Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. As. *q.* $2. New London.
Jour. Polit. Economy. *q.* $3. Chicago.
Journal of the So. of Arts. *w.* London.
Locomotive Engineering. *m.* $2. N. Y.
Light, Heat and Power. *m.* $3. Phila.
Machinery. *m.* 9*s.* London.
Machinery. *m.* 50 cts. N. Y.
Manufacturer and Builder. *m.* $1.50. N. Y.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Metal Worker. *w.* $2. N. Y.
Milling. *m.* $2. Chicago.
Mining Review, The. *w.* $2. Denver.
Mining Industry. *w.* $3. Denver.
Mining World, The. *w.* 21*s.* London.
Mining Jour, The. *w.* £1. 8*s.* London.
Monist, The. *qr.* $2. Chicago.
Manufacturer's Record. *w.* $4. Baltimore
Master Steam Fitter. *m.* $1. Chicago.
Min. and Sci. Press. *w.* $3. San Francisco.
Mechanical World. *w.* 8*s.* 8*d.* London.
Nature. *w.* $7. London.
North American Review. *m.* $5. N. Y.
National Builder. *m.* $3. Chicago.
Nineteenth Century. *m.* $4.50 London
National Car Builder. *m.* $2. New York.
New Science Review, The. *qr.* $2. N. Y.
Paving & Mun. Eng. *m.* $2. Indianapolis.
Peterson Mag. *m.* N. Y.
Progressive Age. *s-m.* $3. New York.
Procd. Engineer's Club. *q.* $2. Phila.
Practical Engineer. *w.* 10*s.* London.
Plumber and Decor. *m.* 6*s.* 6*d.* London.
Power. *m.* $1. N. Y.
Popular Science Monthly. *m.* $5. N. Y.
Railway Age. *w.* $4. Chicago.
Railroad Car Journal. *m.* $1 New York
Railway Engineering and Mechanics *m.* $1. Chgo.
Railroad Gazette. *w.* $4.20. N. Y.
Review of Reviews. *m.* $2.50. New York
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Railway Times, The. £1. 5*s.* London.
Stone. *m.* $2. Chicago
Southern Architect. *m.* $2. Atlanta.
Sanitarian. *m.* $4. Brooklyn.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. N. Y.
Scribner's Magazine. *m.* $3. New York.
Scientific Quarterly. *q.* $2. Golden, Col
Stationary Engineer. *m.* $1. Chicago.
Social Economist. *m.* $1.50. N. Y.
Seaboard. *w.* $2. New York.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y
Steamship. *m* Leith, Scotland.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
School of Mines Quarterly. $2. N. Y.
Sanitary Record. *m.* 10*s.* London.
St. R'y. Elec. News. *m.* $2. Minneapolis.
Sanitary Plumber. *s-m.* $2. New York.
Street Railway Gazette. *w.* $3. Chicago.
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago
Safety Valve. *m.* $1. New York.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
Trans. Am. Soc. Civil Eng. *m.* $10. N. Y
Technology Quarterly. $3. Boston.
Transport. *w.* £1. 5*s.* London.
Trans. Am. Ins of Mining Eng. N. Y.
Trans. of the Wis. Acad. Madison.
Western Electrician. *w.* $3. Chicago.

ARCHITECTURE & BUILDING

Competitive Designs a Failure.

THAT there is great and increasing dissatisfaction with the system of competition in designs is very apparent from the tone of the architectural press upon the subject. A strong editorial in *The Southern Architect* for April voices this discontent, and clearly shows that the system has been detrimental to the art.

On the contrary, notwithstanding the disfavor with which the profession regards the system, it is still much resorted to in the obtaining of designs by owners and building committees. "No one who is familiar with the practice of architecture in the south to-day can fail to see that 'competition' is rapidly becoming the usual method of selecting architectural designs. Several of the leading southern cities, those which have made the greatest advance in architecture, are notable exceptions to this. In fact, wherever there has been much attention paid to architecture by the people, competition has fallen into disfavor, experience having proven it to be generally a failure. But the present generation in the south has had neither time nor money to devote to architecture, is inexperienced in such matters, and has very naturally fallen into the error, which has had its day and passed in other sections.

"The application of the word 'competition' to this method of selecting designs is peculiarly unfortunate, since it conveys an idea very attractive to the man of business and yet wholly foreign to the meaning which is intended. It is difficult to find a word entirely suitable, but it strikes us that *contest* would be better than competition."

The inherent faults in the system are noticed in detail. One of the most serious is that competition precludes study of plans and designs on the ground, and "perfectly free consultations with all persons concerned throughout that study. This is impossible in a competition; few architects can spare either the time or the money to devote to such a concentrated study on a bare possibility of compensation, particularly when they reside at a long distance from the site of the proposed building. As a matter of fact, it is very rare that any design so submitted is a well-studied composition; and the successful architect seldom has the opportunity or inclination to revise his work. He finds himself tied down to a crude, ill-balanced design, and he can never so revise it as to overcome its conditions. In most cases no attempt is made to do so, but, the competition once won, the work is turned over to draftsmen to be developed, while the successful competitor turns his attention to the next competition. Thus even competent and conscientious architects find it impossible to accomplish their best work under such unfavorable circumstances."

The effort is thus reduced to an attempt to please the uncultivated taste of laymen whose knowledge of real architectural requirements, even regarding the necessary heating, ventilation, plumbing, and lighting, is often very small. The competing architects can therefore safely disregard these requirements, and thus produce designs the sole purpose of which is to be cheap and showy. "If sanitation interposes, as it often does, the health of the occupants of the building is sacrificed to some convenience of plan. Any and every requisite of good architecture is deliberrately sacrificed, whenever necessary to secure a 'catchy' picture. By the use of water-color or a sketchy style, they slur over important detail, but make a pretty picture. They sacrifice all that is sound and good and pure for the mere picturesque. On the other hand, the competent and conscientious architect is handicapped in the race at the outset by those very qualities which are so necessary to protect the client's interest. He realizes at once the limitations imposed upon him by cost, by sound construction, by sanitary laws, by pure architecture, and he works constantly within them. He produces an honest, practicable design and plan, which, from the very necessity of the case, does not compare in superficial attractiveness with that of his ignorant or unscrupulous competitor. And in nine cases out of ten it is turned down without the slightest consideration."

It is vain to rely upon reputation as a safeguard against the adoption of defective designs by incompetent building committees; and incompetence is the general characteristic of committees. "Many of the most important elements which go to make up a good building are the very ones not brought out in a competition, and, as a matter of fact, cannot be more than indicated." Neither hidden merits or hidden defects can be discovered except by such study as non-professional men are generally incapable of performing. "The motive for holding competitions is generally that the client does not know what he wants and is seeking for ideas from many sources. But how much better it would be to employ a competent architect to examine in his library reproductions of the best work in the world for suggestions as to style, have him sketch two or three different schemes for consideration, and entrust the rest of it to his superior knowledge of the subject. Instead of this, however, some unknown man, often a mere adventurer, is taken up upon no other recommendation than an attractive sketch,—for that is all that competitive plans ever are,—and, without the slightest safeguard, is entrusted with the expenditure of money, the complex problems of construction, the multitude of architectural details, both inside and outside, which go to make up the real excellence of every design, and the abstruse questions of sanitary science. In fact, on the strength of a mere sketch, which only indicates less than one-third of the essential features of the house, the other features are entrusted to a stranger."

There is, however, an argument for the competitive system, which must not be forgotten. The path to a successful practice is at best a rugged one for the young architect, and this system helps more to smooth it than any other could. It is true that prize competitions presided over by professional architects might better indicate real merit, but the competition that immediately opens the door to actual practice, and enables the beginner to set up a monument of his skill in the sight of all men, is an easier and quicker road to success.

Drawings and Specifications.

MORE work expended on drawings, with perhaps less on specifications, would, in the opinion of Mr. Bannister F. Fletcher, contribute to harmony between architects and contractors. In this utterance he has reference to what, in the title of a paper recently read before the Architectural Association, he calls "Specifications from an Architect's Point of View." The *Architect and Contract Reporter*, which prints this paper (April 5), also prints another by Mr. M. A. Holloway, entitled "Specifications from the Builder's Point of View." These papers may be conveniently reviewed together.

In the first place Mr. Fletcher contrasts recent specifications with those prepared 20 years ago, and finds that from brief documents they have gradually grown to voluminous and wordy ones, comprising matter that "serves only to perplex the clerk of works and worry the builder." A great deal of the extra length arises from the introduction of conditions of contract, which properly belong to the contract itself, and are in most cases entirely out of place in the specification. The function of a specification is wholly descriptive, and anything beyond this tends to confusion. "Do the wonderful little essays on how to lay drains, make terra cotta, mix cast-iron, test steel work or iron work, which we find in so many specifications, protect our clients, or help forward to any material extent the good and efficient workmanship and materials we all desire to see?"

"The system of splitting up a specification rigidly into trades has also much to answer for in introducing elements of confusion and difference. Each architect has his own view as to where a certain article should go, and, if he consistently follows out the trade system, what a number of references have to be made before you find out all about a window, for example! On one page the sash and frame; on another, probably, the fastener and sash-lifts; on another the iron-tongue; on another the linings and architrave; elsewhere the glass; and so on. There are many of these cases where four or five references might be profitably put together, especially when you remember that the practice of allocating the items under trade headings differs considerably. For instance, tile pavings and wall-linings get put into the bricklayer's specification by some, the mason's by others, and the plasterer's by others. Then the concrete bed for the tile-pavings and rubbish thereunder, and the cement surface on which the tiles are to be laid, get into different sections, and so in a simple tile-floor we may have to make four or five references before we get it complete. The phraseology of the modern specification also leaves much to be desired, especially in the constant use of words defining quality. The words 'best,' 'very best,' 'proper,' 'perfect,' &c., are all relative terms of quality, which frequently are quite differently interpreted by the architect and builder, the one using the word in the ordinary sense, and the other in the manufacturer's sense. It is no uncommon thing to find in a trade catalogue the expression 'extra super best,' as meaning something superior to that described as 'best'; and, although it seems absurd to encourage such superlatives, if you want the best, you have to go beyond the ordinary English meaning of the word, and accept the grandiloquent language of the catalogues. The word 'proper' is a frequent stumbling-block, and its use should be discouraged as much as possible, especially in the sense in which we find it,—as, for instance, 'fir proper door frames.' These relative terms of quality should be quite abolished, and the definite expressions of the manufacturers used instead; and by so doing we shall, as regards materials at all events, have a common basis of agreement with the builder. At present quality is left too much to the imagination, and is only implied when it can and should be stated in exact terms."

Discrepancies between specifications and drawings are also a frequent cause of trouble. "In the great majority of cases this arises from the habit of writing a specification and using an old one as a model, and so we get materials specified which the architect does not intend to use, and, when the work is being carried out, points of difference arise. If quantities are supplied, the surveyor can easily adjust the variations in description; but, assuming their absence, each person tendering puts his own construction upon the clause, with the inevitable result that, whichever way the architect wants the work done, an 'extra' ensues. Of course, there are builders and builders, and the architect has to be prepared for the worst type in these days of close competition."

There should be more work put on the small scale drawings in order to avoid minute description in the specifications. "Specifications go out of their true course when they cease to be anything more than descriptions of materials. It seems to me that the necessary documents or instruments of a contract should be, first, the plans, elevations, sections, and detail drawings; second, the description of the materials to be used, which of necessity must be a written document,—for convenience called the specification; third, the conditions of contract, or legal restraints by which you bind the builder to do the work in accordance with the plans and specification, and also bind the employer to pay for the work done." The drawings may be so clear, detailed, and annotated as to render a specification almost superfluous. Of course this means a greater expenditure of time and labor in the architect's office, but it is thought that this would be compensated by the avoidance of difficulties and extras that otherwise come in during the erection of buildings.

Mr. Holloway's paper enumerates the difficulties which builders experience in working from modern specifications. In the main it supports the points made by Mr. Fletcher, but it adds the belief that even with well-prepared drawings and specifications, unless there be mutual confidence between architect and builder, difficulties will inevitably arise.

The Value of Sentiment.

A MOST powerful argument against the modern vandalism that reverences nothing old, and eagerly replaces remarkable structures, around which cluster historical associations, with uninteresting, commonplace modern buildings, was delivered by Col. Lee at a meeting recently held in Boston to consider the advisability of demolishing the old State House. An ambitious new State House has been built behind the old one in Boston, and seven times as large as the old one; and it seems that even in Boston, which claims to be the center of American culture, there is a party in favor of tearing down the old structure. Speaking of the associations connected with the old building, Col. Lee said there had been thirty-five governors of Massachusetts since the old building had been erected, and they had all been good governors. Governor Long, one of the thirty-five, in a previous speech had seemed to think there was no history of importance connected with the old building; but he was reminded that the first century of the existence of Massachusetts had a very interesting history. The war of 1812, in which Boston suffered severely, and the victories of that war were recalled. Through the streets of Boston, and up to the old State House, had marched Hull and Dacre to pay their respects to the governor. In the dome the women of Boston stood, with anxious eyes and hearts, to witness the terrible naval battle between the *Chesapeake* and *Shannon*. Many distinguished visitors, among them Lafayette, have been received and honored there. The great civil war was historically associated with the State House. In speaking of the events of that memorable struggle, Col. Lee became eloquent.

" There was something done in the house in those long, fearful years of agony and weariness, heart-breaking disappointment and losses; the procession of young men coming to offer themselves for service, saluting the governor, like the gladiators the Emperor, ' We, who are about to die, salute you.' Do you suppose there is no feeling connected with these rooms where the governor sat for those four years?—a man of peace called upon suddenly to prepare this State for a fearful war, and preparing it in spite of ridicule, in spite of denunciation, and preparing it so promptly that Massachusetts was the first State; the first men who were sent properly equipped and armed for the war were the men of Massachusetts. The whole world wept for Lincoln's death; are there no tears for Andrew, who fell after the war, as much as Lincoln? He was killed by an assassin, but, if he had not been, he would have died in a short time from head and heart weariness. Do you suppose Governor Andrew could have sat here those four years, night and day,—for he was here much of the time night and day working and enduring, and feeling that he had been, more or less, instrumental in bringing about the deaths of all the flower of Massachusetts,—without any emotions? Was there no association? You have the association of Bunker Hill—for what? A battle of four hours. Has a battle of four years no association for this building—the agony of those four years? Men, haggard with anxiety and grief, and the mourners going about the streets from every house: Rachel weeping for her children, and not to be comforted because they were not. Is there no association for this building, where the headquarters of the whole government of the time were? It seems to me absurd. I should like to read a small sentence from William Morris, on this subject: ' If we are not prepared to put up with a little inconvenience in our lifetime for the sake of preserving a monument of art which will elevate and educate, not only ourselves, but our sons and our sons' sons, it is vain and idle for us to talk about art, or education either. Brutality must be bred out of such brutality.' "

About monuments, the speaker, in an earlier part of the address, said: " A monument—what is a monument? There were some rich men that thought a monument ought to be something new; they had Mr. Cook's idea about it, that it ought to be something new, something in the present style—I don't know whether the dome of St. Peter's had been changed to the present style to attract people, or not. They thought this monument ought to be something new, something pretty fine. When my father took me over to see Bunker Hill, there were the earth-works; one could see the redoubt on which Prescott stood; see the breast-work; see where the rail-fence ran. One could see all the way down to the Navy yard, to Moulton's Point, where the British landed. There was something like a monument; it was not a mere record which the monument afterwards was; it was a reminder of the scene, and that is what a monument should be. You stood there, and all the sentiment of the battle came to you. Now you go there, and you stand upon a hill, nicely graded and all the redoubt and breast-work filled up and erased, and you have the pleasure of seeing an Egyptian obelisk. Well, it is a matter of taste: to me the old earth-works would have been more inspiring, more suggestive, without the Egyptian obelisk."

The Tarrant Building, New York.

THERE are peculiar features of construction in this building, designed to meet special requirements, which render an illustrated and detailed description of them by the architect, Mr. Henry Rutgers Marshall, in *The Engineering Record* (April 15), a good engineering and architectural study. This building, situated on the corner of Warren and Greenwich streets, was erected under contract stipulations in the short space of 4¼ months. "This rapidity of construction made great watchfulness necessary, and led to the adoption of some special devices to avoid risks of unequal settlement, and danger of delay in consequence of faults or imperfections in materials, which devices may be of interest to constructors quite apart from any interest that may attach to the spirit of the design."

"The floor loads had to be calculated to resist large and irregular strains, the maxima being for first floor, 420 lbs. per sq. ft.; second floor, 220 lbs. per sq. ft.; third and fourth floor, 320 lbs. per sq. ft.; fifth, sixth, and seventh floors, 220 lbs. per sq. ft. These maximum strains were unlikely to be realized at more than a few points in the building at any one time; and there was great danger of irregular settlement within the boundary walls."

It was therefore decided "to construct the walls so that they would stand entirely independent of the floors, which latter were carried on an independent system of posts and girders. It was necessary to make the posts of cast iron, instead of wrought iron as I should have preferred, in order to avoid delays. That there might be as little danger as possible of imperfections in the columns due to irregular contraction around the brackets holding the girders, I decided to adopt, on the large columns, a system of annual corbel brackets, which were slid over the columns after the latter were placed in position, these brackets having their bearing upon annular lugs cast on the body of the columns. It was thus possible to cast these corbel brackets of a very unusual size and strength, and thus to reduce, to a great extent, the size of the girders. For these girders I was thus able to use hard pine in almost all cases. This use of pine is preferable, in my opinion, to the use of iron for girders in a building of this character, where sudden hot fires may occur, and where, in consequence of the illiberal terms offered by the insurance companies, it is impossible to show investors that thoroughly fireproof construction will be economical for them.

"The flanges, where the columns were bolted together, were cast a little above and below the bearing surface of the columns, so that there could be no danger of the bearing coming upon these flanges (which are not calculated to stand such strains), as must often happen if the flanges are cast flush with the column ends, when there is inaccuracy in the bearing surfaces.

"The difficulties as to irregular settlement of the floor-weight system were met as follows. The wall columns were anchored to the the walls by bar anchors, playing in slotted lugs cast on the columns. The ground on which the building was to stand was explored by a sand pump and found to consist of fine sand throughout the greatest depth examined. The upper strata proved to be quicksand; and, in order to avoid delay and expense, the foundations were placed as close as possible to the highest permanent water level. The foundations of the column system were carefully calculated to sustain probable pressures which they would be called upon to bear. But, as there was a probability that they might be liable at times to sustain heavier pressures in certain parts than those calculated for, I deemed it wise to attempt a separation of the foundations of the walls, which are not subject to change of weight, from the foundations of the columns against the walls, which are subject to change of pressure. To this end, I carried these column foundations at right angles to the walls against which they abutted. The wall pressures were transferred by arches over these column foundations. Thus, and by a system of inverted arches used on the street wall, the column pressures and wall pressures were brought to bear upon entirely different bodies of the underlying sand."

As already intimated, the detailed drawings of the construction, which cannot be here reproduced, aid much in gaining a clear comprehension of the description. The third- and fifth-story floors are made water-tight, and provided with drain pipes, which, in case of fire, will carry the water off into a court. This protects floors below from damage by water, in case of fire in an upper part of the building. This building has now been occupied for two years with extreme variations of load and temperature in different parts of the structure, and it is asserted that it has met these conditions "without the least sign of injury through settlement."

REMOVING putty from old sashes is not so easy a job as would at first sight appear. It is almost impossible to cut the putty out with the usual hacking knife and hammer without damaging the woodwork. To avoid these inconveniences, and the danger of accidents to clothing and hands when strong acids are used, a good plan is to employ petroleum—three successive coatings of petroleum, at intervals of half-an-hour, generally being all that is required. It may be stated as a reason for this that petroleum penetrates into the pores of the putty and dissolves the hardened linseed oil. In a short time the putty regains its original plasticity, so that in two or three hours after the application of the first coat one can, with the point of a knife, cut out the putty with ease.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*30895. Architecture in Colombia, South America. Ill. C. F. Z. Caracristi (Stone-April.) 900 w.

*30922. Competitions. Editorial (So Arch-April.) 2200 w.

*30923. The Profession of Architecture. William M. Rose, in Kansas City Arch. & Builder (So Arch-April.) 1200 w.

*30934. Specifications from an Architect's Point of View. Mr. Pinks (*Arch*-April 5.) 4000 w.

*30935. Specifications from a Builder's Point of View. A. Holloway (*Arch*-April 5.) 3000 w.

*30936. Architects and Quantities (*Brit Arch*-April 5.) 2500 w.

30950. Constructional Features in the Tarrant Building. Ill. (Eng Rec-April 13.) 1500 w.

30952. On the Application of Color to Architecture. A. T. Sibbald (Am Arch-April 13.) 3500 w.

30953. The Relation of Architect and Client. T. M. Clark (Am Arch-April 13.) 4500 w.

*30963. The Bristol High Cross, Stourhead, Wilts. Ill. (*Builder*-April 6.) 800 w.

*30964. Netley Abbey (*Builder*-April 6.) 2000 w.

*30992. The Early Christian Architecture of Rome. William P. P. Longfellow (Arch Rec-April June.) 6300 w.

*30993. Decorative Art. Candace Wheeler (Arch Rec-April-June.) 2600 w.

*30994. The Colonial Buildings of Rensselaerwyck. Ill. Marcus T. Reynolds (Arch Rec-April-June.) 9200 w.

*30995. A Discovery of Greek Horizontal Curves in the Maison Carrée at Nimes. Ill. William H. Goodyear (Arch Rec-April-June.) 7500 w.

*30997. Architectural Aberrations. — The Cairo. Ill. (Arch Rec-April-June.) 1800 w.

31072. Code of Practice for Sub-Estimating and Sub-Contracting. — Adopted by Master Builders' Association of Boston (Am Arch-April 20.) 1000 w.

We supply copies of these articles. See introductory.

*31081. The Application of Color to Architecture. G. F. Stalker (Can Arch-April.) 1000 w.

*31118. "Architect and Builder." Editorial (*Brit Arch*-April 12.) 1400 w.

31141. The Wind Pressure in Tall Buildings of Skeleton Construction. Ill. W. L. B. Jenney (Eng Rec-April 20) 1600 w.

*31151. The Use of Steel in Large Buildings. Ill. Corydon T. Purdy (Jour Asso Eng Soc-March.) 13000 w.

*31155. Regulations Governing the Erection of Buildings, Applicable to Cities Having a Population of from 10,000 to 30,000. Ill. Compiled by the Asso. of Eng. of Virginia (Jour Asso Eng Soc-March.) 5500 w.

31240. Report of the Condition of the Massachusetts State-House (Am Arch-April 27.) 2000 w.

31241. Exhibition of Architectural Drawings in Boston (Am Arch-April 27.) 2000 w.

*31261. The Fugger and the Schnekin Chapels at Augsburg. Ill. H. W. B. (*Builder*-April 20.) 1800 w.

*31318. Color in Brick and Terra-Cotta Architecture. George M. Fiske (Br Build-April.) 1400 w.

†31349. The New Government House, Rangoon. Editorial (*Ind Engng*-March 23.) 1200 w.

*31355. Floors and Floor Cloth (*Ill Car & Build*-April 19.) 1200 w.

*31356. Domes (*Ill Car & Build*-April 19.) 1800 w.

*31359. Our Cathedrals and Abbeys. Ill. J. Edwin Forbes (*Ill Car & Build*-April 19.) 7000 w.

*31360. Cottages, Ancient and Modern. From Building News (*Ill Car & Build*-April 19.) 1800 w.

31389. The New York Herald Establishment. Ill. (Sci Amer-May 4.) 1200 w.

31391. Silver Gray Roofing Tile (Sci Am Sup-May 4.) 3000 w.

31453. Architects' License Bill as Last Agreed Upon by the Assembly. Also a History of the Bill, by William J. Fryer (Arch & Build-May 4.) 3500 w.

31468. The Ellerslie Cow Barns. Ill. (Eng Rec-May 4.) 1800 w.

†31483. The Bread-and-Butter Side of Architecture. C. H. Blackall (Tech-No. 9.) 2800 w

*31529. Housing the People in London and the Provinces. (Abstract.) Henry Lovegrove (*Arch*-April 26.) 1600 w.

*31540. Rational Building (*Builder*-April 27.) 2200 w.

*31542. North British Railway Hotel and Offices, Edinburgh.—Report on Design by John Burnet, Son and Campbell. Ill. (*Brit Arch*-April 26.) 4000 w.

*31563. A Norwegian House. A. S. T. (*Ill Car & Build*-April 26.) 1600 w.

Serials

18857. Electrical Science for Architects. Ill. Russell Robb (Am Arch-Began Jan. 13, 1894—10 parts to date—15 cts. each).

19078. Problems in Stone-Cutting. Ill. Ed. W. Hind (Stone-Began Jan. 1894—13 parts to date—30 cts. each).

19218. Manhattan Life Insurance Building. Ill. (Eng Rec-Began Jan. 20—7 parts to date 15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (Br Build-Began Jan. 1894—16 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A Ashmun Kelly (*Plumb & Dec*-Began March, 1894—13 parts to date—30 cts. each).

21288. Theatres. Ill. E. A. E. Woodrow (Am Arch-Began April 14, 1894—15 parts to date—15 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (Br Build-Began April, 1894—12 parts to date—30 cts. each).

26069. Modern Steel Fire-Proof Construction. Ill. F. M. Small (Arch & Bldg-Began Oct. 13, 1894—6 parts to date—15 cts. each).

26070. The Planning and Construction of American Theatres. Ill. William H. Birkmire (Arch & Bldg-Began Oct. 13, 1894—7 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. Ill. W. J. Eden Crane (*Ill Car & Build*-Began Nov. 9, 1894—8 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (Arch & Bldg-Began Nov. 24, 1894—6 parts to date—15 cts. each).

27954. The Musical Ideals of Architecture. H. Toler Booraem (Arch Rec-Began Jan.-March—2 parts to date—30 cts. each).

28494. Bricks and Terra Cotta (*Builder*-Began Jan. 5—15 parts to date—30 cts. each).

29253. The Guilds of the Medieval Workers in Stone. Edward C. Weaver (Stone-Began Feb.—3 parts to date—30 cts. each).

30491. Various Systems of Concrete Construction. Ill. Ross F. Tucker (Br Build-Began March—2 parts to date—30 cts. each).

30812. The "Sky Scraper." F. C. Gordon (*Ill Car & Build*-Began March 29—2 parts to date—30 cts. each).

30959. Building Contracts. Arnold Statham (*Ill Car & Build*-Began April 5—Ended April 11—2 parts—30 cts. each).

30996. Lineal Perspective. Ill. G. A. Middleton (Arch Rec—Began April-June—1 part to date—30 cts).

30998. The Alphabet of Architecture. Ill. Harry W. Desmond (Arch Rec-Began April-June—1 part to date—30 cts).

31085. Notes on the Polychromatic Decoration of Churches. George Ashdown Audsley (Arch & Bldg-Began April 20—2 parts to date—15 cts. each).

31319. The Modern Office Building. J. Hollis Wells (Br Build-Began April—1 part to date—30 cts).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

The Shrinking and Swelling of Excavated Material.

THE measurement of excavated material has probably been one of the most fruitful sources of disagreement and dispute between engineers and contractors. A prominent example of this has been furnished in the harbor works at Quebec. Introducing a paper under the above title by a brief reference to the suits and countersuits bearing on the question of allowances to contractors by engineers in charge of these improvements for what may be termed the swelling or expansion of excavated material as compared with the space it occupies *in situ*, Mr. Charles Baillairge, C. E., Quebec, in *The Canadian Engineer*, discusses the subject.

The motive of the paper is "to enlighten the profession and invite argumentation on a technical, important, and very much disputed subject." Mr. Baillairge asserts that "very few authors allude to the subject in any way, and few or no experiments have been made to ascertain and tabulate the ratios and their time-varying values."

"Trautiome has it, under the heading, not of expansion, but of 'Shrinking of Embankment,' that, 'although earth, when first dug and loosely thrown out, swells about one-fifth part, so that a cu. yd. in place averages about 1.2 cu. yds. when dug, or 1 cu. yd. dug is equal to 5/6 or 0.833 of a cu. yd. in place, yet, when made into embankments, it gradually subsides, settles, or shrinks into a less bulk than it occupied before being dug.' The following are shrinkages taken from Trautiome: gravel or sand, about 8 per cent., or 1 in 12 1/2 less; clay or sand, about 10 per cent., or 1 in 10 less; loam, about 12 per cent., or 1 in 8 1/3 less; loose vegetable surface soil, about 15 per cent., or 1 in 6 2/3 less; puddled clay, about 25 per cent., or 1 in 4 less."

Mr. Baillairge has substantiated these statements for a solid yard of stone reduced to road metal, but not for the other materials; and there seems to be a chance here for good experimental work in some of the technical schools, which could, after a time, furnish tabulated statements that would be authoritative. The experimental work done in these schools is not the least of their public benefits.

"Now, while common earth or dirt, when freshly excavated, may swell some 20 per cent., or one-fifth, as Trautiome says, such is not the case with sand of the description dredged on the site of the Quebec harbor works; nor has the writer upon trial found it to expand or occupy in the loose a bulk greater by more than 5 per cent. than in the solid or *in situ;* and from experiments purposely made from successive heights by the writer, and on which to base his testimony as given in the exchequer court in one of the suits alluded to, he found that the sand, as excavated and handed up by the dipper and then dumped into the scow, did fall just with such a thud or force or weight of impact as to consolidate it or cause it to enter into exactly the same space as it occupied *in situ* in the bed of the river, and that consequently the contractors could claim no allowance for expansion on material of the kind."

"Many apparently plausible arguments were adduced to shake the faith of the court in the premises,—that is, in the result arrived at by the experimental work of Mr. Steckel on some 1,500 yds. of the material, as already stated,—such as the fact of the out or overflowing water from the surface carrying with it a heavy percentage of the stuff; and so it would, had it been mud or sludge instead of sand; as if the court were blind enough not to see that, even if the assertion were true, it would be no argument anent the correctness of the result arrived at, since the stuff, if any, falling overboard, would flow or fall back into the excavation, and be scooped or dipped up and again find its way into the scow."

One of the contractors showed that measurement in the scow "ran short of the measurement *in situ*," owing to the fact that some of the material was washed away when loosened, the current in such cases doing a part of the work for which the contractor was paid. A distinction is made between allowances due to the fact that excavation cannot be "confined to the exact figure of the section," and the expansion due to the swelling of the material. The tendency of contractors to overdo their work "when paid by the yard," particularly if the rate at which they are paid is found to be profitable, is also one of the facts of engineering experience. Cases of refilling also occur. If excavation material be frozen, it may be "loosened and swollen" before it is excavated. The effect of the presence of worms and of foraminifera, is also noted. This is illustrated by the structure of ant-hills. Common earth may swell when excavated, and then become again compacted by the filling up of interspaces. This is illustrated by the settling of oats or other grains of elongated forms when a receptacle containing them is shaken. On the whole, there is outlined in this paper a subject of great interest and importance, which we hope will be followed by systematic experimental investigation.

Prevention of Ice at Intakes.

THE past winter was prolific of trouble from ice obstructions which in many cases threatened the continuity of water-supplies, and in some cases caused great inconvenience by lessening or stopping flow through pipes. English people suffered much from this cause, the cold having been unusually severe in many districts. More than ordinary embarrassment of industries using water power resulted from anchor ice. The prevention of such obstructions has been made the subject of renewed thought and discussion in engineering societies. The different means employed in various places for prevention of ice obstructions at intakes are stated in *The Engineering Record* (April 27) in an abstract of a report of Mr. Edward B. Guthrie, assistant chief engineer of the department of public works, Buffalo, who has been inspecting "the water tunnels of Chicago, Milwaukee, Cleveland, and Erie, with a special view of learning what methods were adopted to keep them free from ice." At Chicago the ice is combated in several ways. One of the cribs at that city is situated 2 miles out in the lake. When Mr. Guthrie visited it, "the temperature was at zero and the conditions favorable for examining the method of keeping away ice. The 2-mile crib is pentagonal and measures 58 ft. on each side. It incloses a well 22 ft. on each side, with two shafts and four ports, each 4 ft. high and 5 ft. wide. Surrounding the crib at a distance of 30 ft., except for an open space of 30 ft., is a breakwater, forming a channel in which the water passes from the lake to the ports. On the day of the visit there was a tug with its stern in the opening of the break water, and men were poling ice into the outward current created by the propeller, so as to keep the channel into the lake free from ice. A large timber beam had been placed across the opening in an unsuccessful attempt to keep out floating ice. The main difficulties lay in keeping the channel between the breakwater and crib free from floating and slush ice, and the ports free from slush and anchor ice. Chains are laid through the ports, and are dragged back and forth to keep them clear. Moreover, three of the ports are provided with iron pipes slung vertically outside. The lower ends of these pipes are bent at right angles and drawn down to form a nozzle of smaller diameter. There are two steam pumps on the crib, from each of which a hose is carried to the upper ends of the pipes and water forced through them at 140 lbs. pressure. These streams are directed to all sides of the ports, thus forcing the ice into the well, where some of it is scooped up by nets or wire baskets, the greater part finding its way, however, into the tunnel. The water in the well was in a continual swirl, showing the rapid draft into the tunnels."

At the 4-mile crib, as it is called, at Chicago, little trouble has been experienced. "The surface of the water in the well shows little or no agitation. The only provision for combating ice consists of wire baskets to scoop it up; these are hoisted by a steam engine to an overhead trolley, by which they are run out to the side of the crib and discharged into the lake."

At Milwaukee, where 24,000,000 gallons are pumped daily, the intake is about 1200 ft. off shore and consists of the turned-up end of a pipe 3 ft. in diameter, protected by piles driven around it. Here "there was trouble for a time with anchor ice, and a 50 h.-p. boiler was set up, and connected by a 2-in. steam pipe with the inside of the intake. When ice begins to form at the inlet, steam is turned on, and the trouble ceases in 15 minutes. A brick-lined tunnel 7½ ft. in diameter is now under way at a depth of 140 ft., which is to terminate at a twelve-sided crib measuring 56 ft. in outside dimensions and provided with four ports 5 ft. wide and 3½ ft. high for emergency use. From the crib two parallel 5-ft. cast-iron pipes are laid in a dredged channel to a point 5000 ft. further out, where the water is 60 ft. deep. Here the ordinary supply of water will be taken through a submerged intake, consisting of a crib about 10 ft. high surrounding the upturned ends of the pipe. On the top of this crib is a timber grating with openings 2 in. wide and a total combined open area several times larger than the area of the pipes."

At Cleveland the water is taken from the lake through two brick-lined tunnels, the intakes being 9000 ft. off shore. A single pentagonal crib, 54 ft. on each side, 60 ft. high, and submerged to a depth of 38 ft. has a well with "sides 19 ft. long, in which there is a 10-ft. shaft running down to the 5-ft. tunnel, the shaft to the 7-ft. tunnel being located in one of the pockets of the crib.

"There are three ports leading to the well, each 5 ft. wide and 2½ ft. high, with sills 24 ft. below the surface of the water. The ports of the shaft in the pocket are five in number, each 3 ft. square and cut through the outer wall of the crib at various levels. Originally the 10-ft. shaft inside the well had a wooden cap, leaving a space between it and the top of the shaft. This space became stopped with ice, and caused so much trouble that the cap was removed, since which time there has been little or no difficulty." Mr. Guthrie has arrived at the conclusion "that, if water could be drawn at a sufficient depth through a sufficiently large area and the inflowing current reduced to a few inches a second, there would be little or no trouble from ice. Acting upon this theory, the submerged intake constructed about as described above for Milwaukee has been devised; this type has been in successful use in Toronto." The tendency since the first of these cribs was built at Chicago 30 years ago has been toward larger ports and slower velocity of in-take, and experience confirms the wisdom of this modification.

River and Harbor Improvement in the United States.

A PAPER, largely historical, by Mr. L. Y. Schermerhorn, C. E., is a feature of *The Journal of the Franklin Institute* for April. It points out that the articles of confederation (1777 to 1789) conferred upon congress "no power over commerce or navigation . . . . Each State enacted such laws as it pleased. Rivalries existed whereby one State competed with another: one, by more favorable navigation laws, sought to increase its own trade and commercial advantage at the expense of sister States." At the time our national constitution was adopted the States were unanimous in the opinion that power to regulate commerce should be supremely vested in the congress. Certain taxes levied by the States were, however, continued by consent of the general government, and acts of this kind were continued down to 1828. The first appropriation made by congress for improvement of water ways was in 1802, when $30,000 was voted "for the erection of piers in the river Delaware." "In 1841 congress provided that to each new State thereafter admitted to the Union 500,000 acres of public land should be set aside, the proceeds of the sale of which was to be faithfully applied by the State to the building of bridges and the improvement of roads, canals, and watercourses, over which the United States should have the right to transport, free of toll, its mails, troops, and munitions of war." During the interval between 1838 and 1866 only "three regular river and harbor bills were passed." A few small appropriations for local purposes—mainly repairs of works already built—were made. From 1866 to 1882 "annual river and harbor bills were passed, usually in annually increasing amounts. Up to 1870 the total of appropriations for such improvements was $31,648,600. Up to 1894 the total is $262,845,900. It is thus seen that during the last 24 years the appropriations have been $231,147,300, or an average of nearly $10,000,000 a year.

"The planning and execution of these works of river and harbor improvement is a part of the duty of the corps of engineers of the army, which is practically a bureau of the war department, of which the secretary of war is the head. In this work the entire country is divided into five divisions,—*viz.*, the Pacific, Northwest, Southwest, Northeast, and Southwest; and over each is placed one of the senior officers of the corps, usually with the rank of colonel, in the capacity of supervising engineer. These five divisions are further sub-divided into from forty-five to fifty districts, each in charge of an officer of the corps, and generally known as the local engineer-in-charge of river and harbor improvement. The official head of the corps is the chief of engineers, with the rank of brigadier general. Plans and projects for improvements, with estimates of cost, and also all reports upon examinations or surveys called for by congress, are submitted by the local engineer of each district to the supervising engineer of the division, by whom they are transmitted to the chief of engineers, with such comment as, in the judgment of the supervising engineer, may be necessary. At least once in each year the supervising engineer visits each district in his division, and, accompanied by the local engineer-in-charge, makes a careful inspection of all works in progress. Upon the works of river and harbor improvement there are now engaged, exclusive of the chief of engineers, about 77 officers, with the following rank,—*viz.*, 6 colonels, 9 lieutenant-colonels, 15 majors, 18 captains, 21 first lieutenants, and 8 second lieutenants. The second lieutenants of the corps, after being graduated from a 4 years' course at West Point, are assigned to a post-graduate course of 3 years at Willett's Point. This course is essentially a school of practice under the tuition of officers of the corps, in which the young engineer is taught to coördinate his theoretical knowledge with its practical application to the arts of fortification, defences, and river and harbor improvements. As a further preparation for active practice, he is often subsequently assigned to duty under a senior officer as an assistant upon constructive works, thereby passing through a novitiate which well prepares him for the active practice of his profession."

"The administration of the works of river and harbor improvement requires the employment of large numbers of civilians, in the capacity of assistant engineers, surveyors, and draftsmen; and a large body of men has been drawn from the engineers of the country to fill these positions. To supply increasing demand for such services, nearly all our engineers have introduced into their courses instruction relating to river and harbor improvement."

Preservation of Iron Structures Exposed to Weather.

DOUBT having arisen that coatings of iron oxid paint applied to iron structures were effective in preventing the formation of rust underneath the coatings, M. E. Gerber, C. E., was commissioned to make an examination of a number of large structures to which this kind of paint had been applied, and to report upon the condition of the paint and of the metal under it. The following bridges and structures were examined. "The bridges at Cairo (Ill.), Memphis, Merchants, at St. Louis, Bellefontaine (near St. Louis), Leavenworth, Rulo (Neb.), Nebraska City, Plattsmouth, Union Pacific Ry. Bridge, Omaha and Blair (Neb.), Sioux City, and Alton (Ill.), all painted with one kind of pure iron oxid paint, mixed with pure linseed oil. The drawbridge at Omaha, the lower bridge at Winona (Minn.), the union passenger station at St. Louis; the State St., Wells St., Clark St., Adams St., Jackson St., Van Buren St., Wisconsin Central Ry. bridge at Polk St., in Chicago; all of which were first painted with red lead and subsequently with some other paint, usually oxid of iron. The wagon bridge at Omaha, the Madison St. bridge and Madison St. viaduct in Chicago, painted with an unknown paint, but having the appearance of being a white lead tinted. The Rush St. bridge and viaduct, Lake St. Elevated Ry. bridge, Jones & Laughlin's bolt shed, Adams St. viaduct, Jackson St. viaduct, Metropolitan Elevated Ry. bridge, Harrison St. bridge and viaduct, Polk St. draw and viaduct and Taylor St. bridge and viaduct, at Chicago, all of which were first painted with what appeared to be an iron oxid paint. Visits were also made to the shops of the Missouri Valley Bridge & Iron Works, and Lassing Bridge & Iron Works."

The results of the examination are embodied in a paper read before the American Society of Civil Engineers (May 1), an abstract of which is printed in *Engineering News* (April 18). The conditions discovered are such as to allay apprehension that this method of preservation may not be regarded in most cases as reliable. All the structures named were found to have rusted more or less under the paint. "In some cases this was very little, in others much worse, and it was found on all parts of the bridge, whether specially exposed to weather or not. The rust was in spots in most cases, the limits of the spots being often quickly reached. In most bridges the clean metal predominated. It was found, in general, that a metal which had come from the rolls with a smooth surface was much less likely to have rust under the paint than one which had left the rolls with a rough surface. Plates were, as a rule, freer from this rust than shapes or angles, though, when the latter were smooth, they were clean. Eye-bars were usually free from rust, and those portions of members in iron structures which had been heated in process of manufacture showed also less rust than others. The age of the structure did not seem to have special influence on the rust under the paint, as some of the bridges which had stood longest were much cleaner than others which had been built only a few years."

Of the bridges named, the Omaha and Blair bridge, though rusted externally, was found in good condition under the paint. It was painted in 1884, and has not since been repainted. Under white lead marks put on in the mill the metal was in all cases found clean. The rust under the paint was generally thin and inactive. Bridges that had been given a coat of oil in the shop were found cleaner under the paint than those which had not received such treatment. Paint composed of pure iron oxid and pure linseed oil was found tough and strongly adherent.

"The paint on the bridges painted with red lead, with the exception of that on the drawbridge at Omaha, was universally brittle and very easily removed. The same was true of the mill and shop marks, wherever found. On the Winona bridge, which had been painted with white lead as a finishing coat, the paint was cracking wherever exposed to sun. A few structures painted with carbon paint showed this to be non-cohesive and easily removed. The paint on the bridges in Chicago, which were painted with iron oxids, other than the one referred to above, was brittle in some cases, and in others tough; it appeared much better, however, than the red-lead paint."

Bridges painted with red-lead required repainting in 7 years at the outside, while most of them required repainting in 2 or 3 years. The oxid of iron is not the cause of the rust spots under the paint; these are precisely like those which appear on iron housed in shops. To secure best results from painting, thorough cleaning from existing rust spots is requisite. Scraping or the sand-blast should be employed for this purpose. Mr. Gerber thinks it to be impracticable to secure thorough cleaning of the plates, etc., by hand, and adds that "under present conditions it is desirable to oil metal in bridge shops rather than to paint it, inasmuch as oil is not an opaque covering, and the condition of the metal shows for itself, and can be improved, after erection and before painting, if necessary."

The Abuse of Cement.

THE following is an abstract of a paper read by B. Butler before the Society of Engineers (April 1), and printed in *The British Architect* (April 5). There is no doubt that failures occurring with cements of good repute frequently result from the causes herein set forth.

"In very hot weather it is no uncommon thing for a cement to have a very quick initial set, and in using such a cement, therefore, in order to obtain its full strength, it must be mixed and in its allotted position within a very few minutes of adding the water. This often entails the mixing of very small quantities at a time, and, if due precautions are not taken a larger quantity is mixed than can be manipulated before setting commences. This generally results in the use of additional water, and the serious detriment, if not total destruction, of the setting properties of the cement. Many cases of failure have occurred which (the cement being of good quality, though somewhat quick in setting) point strongly to over-manipulation or 'killing.'

"The admixture of a very small proportion of dirt or loam is quite sufficient to materially deteriorate the strength of a concrete, and too much stress cannot be laid upon the necessity for seeing that all aggregates are free from any foreign dirty matter. A case of structural failure came under notice a short time back, in which the cement used was perfectly good, but the finer portions of the aggregate consisted of very fine sand, so fine that 60 per cent. passed through a sieve having 70 coles per lineal inch, and 80 per cent through a sieve having 50 holes per lineal inch. The structure of which it formed part had to bear a considerable thrust and, to aggravate matters, instead of this sand being properly mixed, large patches occurred in which there was no cement at all. In addition to this, the sand contained a considerable portion of loam or foreign matter, and it is not to be wondered at that failure resulted."

The neglect to properly cool, or aërate, cement is a frequent cause of trouble. To use cement hot from the mill is to court failure, though under some circumstances it may not fail. It is recommended, where cement is used in considerable quantities, that cooling sheds be constructed, with good dry boarded floors upon which the cement may be spread and aërated before use.

Exposure of cement either to hot sunshine or to frost may greatly injure the results. The first evaporates water needed to complete the crystallization, and frost acts by expansion to injure the surrounding concrete. During severe weather cement, if used, should be protected from frost. Careful attention to the following points is necessary to secure good results. (1) The cement should be sound, well ground, and of steadily increasing strength. (2) The setting properties of the material must be carefully ascertained. (3) The cement must be properly matured before use. (4) While setting, it must be protected from extremes of temperature. (5) The aggregate must be clean and well-proportioned.

American Originality in Engineering.

IN speaking editorially of the construction of the drainage canal now under construction at Chicago, *Engineering News* congratulates American Engineers, that notwithstanding they had before them the Manchester, Baltic, Suez, and other great European works of this kind they did not follow these precedents, but adopted original methods of their own. "With practically no experience in canal excavation on so large a scale, both engineers and contractors have evolved methods and apparatus for carrying on such work which will challenge the competition of the whole world for efficiency and economy. The importance of this fact is more far-reaching than the present work. It is only a matter of time when the proposed canal across the Isthmus of Nicaragua will be begun, let us hope by American capital and under American control, and then it will be to American engineers and contractors that we must look for successfully accomplishing the work. The surety that they can be depended upon to do it expeditiously and economically, which the experience of the Chicago drainage canal has afforded, cannot but help to aid in securing the faith of capitalists and the federal government in the feasibility of the great interoceanic canal." All this is well deserved praise for the engineering skill, and ready resource that have been displayed in the progress of this work, and which command world-wide admiration.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Bridges.

†30855. The City Avenue Bridge over the Schuylkill River, Philadelphia. Ill. J. Vaughan Merrick (Jour Fr Inst–April.) 1400 w.

*30904. Girder Bearings. Editorial (*Eng*–April 5.) 2200 w.

31047. Preservation of Iron Structures Exposed to Weather. (Abstract.) E. Gerber (Eng News–April 18.) 2000 w.

31049. Proper Relation of Elastic Limit to Ultimate Strength in Structural Steel.—Letters from William R. Webster, A. C. Cunningham and Charles E. Stowell (Eng News–April 18.) 2400 w.

*31152. Notes on a Broken Pinion Shaft. Ill. Onward Bates (Jour Asso Eng Soc–March.) 900 w.

*31153. Country Road Bridges. C. C. Wentworth (Jour Asso Eng Soc–March.) 2200 w.

31203. The Erection of Bridges. Ill. Charles H. Wright (Eng News–April 25.) 1800 w.

31206. Notes on Soft Steel for Bridges. Harry J. Lewis (Eng News–April 25.) 4500 w.

31609. The Measurement of Live-Load Strains in Bridges. Ill. J. Jay Hankensen and William H. Ledger (Eng News–May 9.) 5800 w.

Canals, Rivers and Harbors.

†30857. The Rise and Progress of River and Harbor Improvement in the United States. I. Y. Schermerhorn (Jour Fr Inst–April.) 6500 w.

30884. Growth of Traffic Through the St. Mary's Falls Canal (Eng News–April 11.) 1300 w.

*30940. The Improvement of the Lower Seine (*Trans*–April 5.) 3200 w.

30947. Repairs to Mohawk River Dam, Cohoes, N. Y. Ill. (Eng Rec–April 13.) 1000 w.

31045. Vertical Lift Lock for the Erie Canal at Lockport, N. Y., with Editorial. Ill. (Eng News–April 18.) 8200 w.

*31150. The Chicago Sanitary District Canal. Isham Randolph (Jour Asso Eng Soc–March.) 4000 w.

31224. The North Baltic Canal Locks, Holtenau. Ill. (Eng Rec–April 27.) 1300 w.

*31407. The Panama and Nicaragua Canals (*Bd of Tr Jour*–April.) 500 w.

31427. The Location of the Nicaragua Canal. Editorial. Ill. (Eng News–May 2.) 1100 w.

*31442. The Public Levee at Winona, Minn. Ill. Fred H. Pickles (Paving–May.) 1300 w.

31611. Cost of Dredging in the Lower Danube. Charles H. L. Kuehl (Eng News–May 9.) 400 w.

Irrigation.

*30834. Irrigation Surveying in California. —Field Work in Locating the Canals. Ill. C. E. Fowler (Eng Mag–June.) 3000 w.

30981. Water Right Contests, From Spokesman's Review (Eng & Con–April 5.) 2000 w.

†31272. The Conquest of Arid America. Ill. William E. Smythe (Cent Mag–May.) 6500 w.

31410—$1.50. The Santa Ana Canal of the Bear Valley Irrigation Company. Ill. William Ham Hall (Am Soc Civ Eng–Feb.) 420000 w.

Miscellany.

30864. The Swelling and Shrinkage of Excavated Material. Charles Baillairge (Can Eng–April.) 2000 w.

*30937. The Abuse of Cement. (Extract) D. B. Butler (*Brit Arch*–April 5.) 1500 w.

*31154. Portland Cement Concrete at Fort Point. George H Mendell (Jour Asso Eng Soc–March.) 3500 w.

31425. The Effect of Freezing on Cement Mortars. Percy L. Barker and Henry Allen Symonds (Eng News–May 2.) 4000 w.

31430. A Heliotrope Flag for Engineers. Ill. Walter C. Parmley (Eng News–May 2.) 500 w.

†31488. Notes on Cement Laboratory Work. I. O. Baker (Tech–No. 9.) 2000 w.

†31490. Hints Relating to the Practice of Railroad Surveying. A. C. Schwartz (Tech–No. 9.) 9000 w.

Serials.

27071. Graphic Methods of Taking Out Areas, Banks and Cuttings. Ill. R. E. (*Ind Engng*–Began Oct. 27—3 parts to date—45 cts. each).

28498. Thames Bridges. Ill. (*Engng*–Began Jan. 4—9 parts to date—30 cts. each).

30177. Irrigation in Peru. Ill. (*Engng*–Began March 8—Ended March 12—3 parts—30 cts. each).

30946. The Rivers of Central Asia. Ill. E. A. Sibold (*Ind Engng*–Began March 16—1 part to date—45 cts).

31039. The Baltic Canal and the Baltic Traffic (*Fairplay*–Began April 12—3 parts to date—30 cts. each).

31117. Traction of Boats on Inland Waterways. W. H. Wheeler (*Eng*–Began April 12—1 part to date—30 cts).

DOMESTIC ENGINEERING

The Best Position for Radiators.

W. H. PENNELL in *The Metal Worker* (April 20) holds that the proper position for radiators is not near the glass, as has hitherto been generally believed, but at some point remote from or opposite to windows. If the position of radiators had been studied only by a consideration of theoretical principles (in which case the overlooking of a single point might be fatal to accuracy of conclusions), Mr. Pennell's argument might stand a better chance with heating engineers. Unfortunately for his theory, the subject has been studied experimentally, and the results of experiment do not accord with his views. Thus he argues:

"A stove throws out or radiates heat laterally as well as upward, so that the room seems to be heated from the heat-rays thus sent off, for these rays are so strong that they quite conflict with the idea that the air becomes heated, and that the room is heated by the circulation of the air. When the air absorbs heat,—becomes heated,—it expands and rises very rapidly. The cause of the upward rush of the air being the heat absorbed, it is evident that the air will continue to rise as long as the amount of heat is constant. The heat from a column of heated air is absorbed or extracted slowly by the surrounding cold air, but, when a solid body is encountered, the heat is very rapidly discharged. As the air loses its heat, it is condensed, and, becoming heavier, it will fall towards the floor. The pouring of water from a vessel upon an iron plate from a considerable height will illustrate inversely the action of the air pouring out of a furnace-register up through the air of a room until it strikes the ceiling. As the water would flow away toward the lower portion of the plate, so the air flows away toward the colder wall more rapidly than in the other direction. As it flows along the ceiling, followed constantly by the renewed current, parting with its heat all the time, it seems drawn toward the colder portion more rapidly, so that, if there is an exposed wall or a window, the currents will be found to be most rapid in that direction. A simple experiment will determine this. Place a bit of aromatic gum or any smelling tincture upon the register of a hot-air furnace, and notice how much more quickly you will get the odor at a window than in any part of the room. When the heating apparatus is in the room to be warmed, whether it be a stove, a steam radiator, or hot-water radiator, the air is warmed by contact with the heater. Radiant heat is noticed most strongly from the stove, and least from the hot-water radiator. In fact, in moderate weather, when the water in the boiler is not over 100°, no radiant heat is recognized, horizontally, from a hot-water radiator. The currents of air coming in contact with the heated iron seem to carry all the heat in vertical lines. Because this is so, we will take the hot-water radiator to determine the proper place in the room for the radiator to best heat the room. It is evident that the air of the room must be warmed, and with it the walls of the room, the furniture, and all the solid matter of whatever nature, in the room, all to an equable temperature. What this temperature will be must be determined by the size of the radiator and temperature of the water. . . The moment the water is heated, the air in contact will rise at once from every part of the heating surface, being supplied from below by the colder air flowing in to take the place of that sent up toward the ceiling. The upward stream being constant, the flow toward the radiator must be equally constant, and the current toward the radiator will be the colder air, that near the floor the coldest, so that the very coldest place in the room will be at the floor near the radiator. We have seen that the air rises constantly to the ceiling, flows along the ceiling, parting with a portion of its heat down the walls to supply the current that is all the time flowing toward the radiator, parting with the heat by contact with the walls, falling the more rapidly the more it is cooled, and most rapidly down the colder walls. Glass is transparent to heat, and so down past the windows the current flows most rapidly, but, as the current is drawn most strongly toward the window, a larger portion of the heated air is drawn in that direction, and therefore a larger quantity of heat will be carried to the floor, where, parting with still another portion of heat, the air will flow toward the radiator, to be again heated and sent into circulation. This should make the floor near the window the warm place, if the radiator is placed where it should be, upon the opposite side from the window. A careful study of the subject will convince one that the proper place for a radiator in a room is not under a window 'to make it comfortable to sit in'; and yet we find some who will place radiators where they would not put a stove. I have seen radiators set into a recess, with a screen in front under a window, cutting off all circulation of air."

Now, this all sounds very well, but there remains the fact that, no matter whether effects ought to be as Mr. Pennell describes, or not, a little experiment with good thermometers shows that they are not so. Although the colder air flows toward hot bodies placed on the floor of a room, and the warm air at the top flows toward the colder windows, just as Mr. Pennell says, it does not follow that the colder part of the room is at the floor near the radiator. This would perhaps be the case, did the air part with heat after reaching the mean temperature of the room, and so come back to the radiator considerably colder than, as a matter of fact, it does come, after a room has once been warmed to a comfortable temperature. But, in the use of good direct steam or hot-water radiators, there is considerable heat given off to the floor near the radiators, and the air flowing over that is in most cases warmed to a temperature above that of the mean temperature of the room before getting into actual contact with the radiator. Neither is glass transparent to dark heat, such as emanates from radiators, as Mr. Pennell asserts.

Flueless Gas-Stoves.

It has been alleged frequently that the use of gas-stoves without flues to carry away the products of combustion is injurious to the occupants of rooms containing such stoves. This allegation is taken up in *Journal of Gas Lighting* (April 2), in an elaborate editorial review of an investigation made by Mr. Thomas Fletcher printed in the *British Architect*. This investigation related to the effect of Fuller's gas-stoves used in the chancel of a chapel in London. The first-named journal says of these stoves that "the statements made against them were so plausible and neatly put that they required consideration before their utter fallacy and incorrectness could be seen; and the facts were of very considerable importance, as they proved beyond question, not only the conditions caused by flueless stoves, but also the comparative impurities from different sources and the danger of attending crowded meetings." The alleged objections to the flueless stoves were "that they generate thousands of cubic feet of carbonic acid, which is dangerous and unhealthy; that the gas, when burning, pollutes the air with its organic impurities; that the sensation of welcome warmth prevents the badness of the atmosphere from being at once recognized, although the carbonic acid gas will produce its effect on the congregation," and "that the method of heating renders the air quite unfit for breathing."

"The building in question has a total floor surface of 47 ft. by 41 ft. The average height being 24 ft., the cubic space is 46,248 ft. The average congregation numbers 600. The floor surface is consequently 3⅕ sq. ft. for each person, as against the 8-ft. minimum for board schools for infants. The cubic space for each person is 81 ft., as against 240 ft. minimum for a registered common lodging-house. These data are taken from Dr. Whitelegge's text-book on 'Hygiene and Public Health.' The building is lighted by 96 gas-burners. The consumption is not given; but, taking it at the low average of 3 cu. ft., the total consumption will be 288 cu. ft. per hour for lighting only. The eight 'chancel' stoves for warming burn a maximum of 15 cu. ft. per hour each,—a total of 120 cu. ft. But it must be noted that these are never used while the congregation are assembled; they are lighted for some hours in advance only."

Computing the exact amount of carbonic acid gas produced by the four gas-stoves, it is found to be 61 cu. ft. per hour, instead of the "thousands" alleged, while the 600 persons assembled would exhale in the same time 480 cu. ft. of this gas and the gas-light 147. The total carbonic acid from the three sources would be 688 cu. ft. The stoves, therefore, were responsible for less than nine per cent. of the entire product. With reference to the accumulation of this gas in the chapel audience hall, in the absence of any ventilation whatever, and during the time in which the room was occupied, Mr. Fletcher found it to be 1.43 per cent., of which less than $\frac{1}{10}$ was due to the gas-stoves. Carbonic acid present to this extent in an apartment, when derived from simple combustion of fuel, is not injurious. That exhaled from the lungs of 600 people collected in a room of the cubic capacity named would, on the other hand, be contaminated with organic impurities which would, even in an hour, become offensive and injurious. A real defect of the flueless gas-stove is not that it contaminates the air by the products of its combustion (of course on the supposition that the gas is fit to be used as fuel in such stoves), but that it does not assist ventilation, as is the case with stoves that deliver the products of combustion into chimney-flues. The latter draw air from the apartment and pass it into the chimney. To replace that which thus flows out fresh outside air flows in, and thus a change of air is all the while going on.

Another defect that may result from the use of defective burners is the production of carbonic oxid, which, unlike carbonic acid, is an active poison, even when largely diluted, and which, when present in quantity too small to destroy life, produces a variety of unpleasant and injurious effects upon the animal economy. This defect may exist in oil-stoves as well as gas-stoves. Another objection to flueless gas- and oil-stoves is that a product of the combustion is water. The air in a room heated by either of these appliances is moistened artificially beyond the normal degree for a room heated by a stove with a flue. This, however, is objectionable only in apartments where dryness of the air is essential to the preservation of its contents in good condition. Thus polished steel articles will rust more readily in a shop heated with flueless gas-stoves than in one heated by steam, hot water, or a stove connected with a flue.

House Sanitation.

THE argument sometimes used against modern sanitary teaching—to wit, that a former generation lived long, useful, and honored lives without modern sanitary rules and appliances—is well answered by Dr. Moreau Morris in *The Sanitarian* for May.

"Some carpist, ignorant of the laws of healthy life, asks: 'Why was it that our ancestors were, many of them, long-lived and more healthy than the present generation, who knew nothing of the new-fangled terms of hygiene, sanitation, microbes, germs, disinfection, fumigation, etc., now so patent to everybody? They lived healthy, happy, prolonged lives.'

"With Yankee instinct we will answer by asking him a question.

"Did any of that ancestry live under any similar conditions? Do we find that they lived in those days in houses heated by furnaces or honeycombed by steam-pipes, with scarcely any ventilation, breathing the vitiated air of warm, close bedrooms, the noxious, sulphurous emanations of gas illumination, the poisonous sewer-gases eliminated by animal and vegetable decomposition, all of which fill not only our houses, but even our out-door air impregnated with the offensive effluvia of filthy streets, rows of overflowing garbage receptacles polluting the atmosphere? Did they spend their time in rounds of excitement, in various excesses of parties, balls, theatres, operas, and teas, turning night into day, laying their weary heads upon sleepless pillows, indulging in unwholesome luxuries at unreasonable hours, suffering the untold horrors of chronic indigestion, to become unnerved and physically exhausted by hasty meals, competitive mental activities, railway rushing from town to town, stock-bulling or -bearing, working in factories, sweat-shops, or the thousand and one things that go to limit and destroy almost every chance for longevity? How long, do you think, they could live in this cyclonic kind of life that the present generation manage to endure?

"True, our present methods of living are wrong, and hence the sanitarian, the hygienist, must necessarily come to the front and sound the note of warning, point out the methods, the remedies, and the preventives that may limit the dangers of our environment. No; they lived in pure air, broad sunlight, with rain-baths to wash down into mother earth floating microbes; slept in cool, well-ventilated bedrooms at seasonable hours; ate plain, simple food; worked physically and mentally with even tenor; were not compelled to resort to drugs to obtain sleep nor combat indigestion. Happy in all the relations of life, with healthful occupations, free from the disturbing cares and anxieties of a crowded city life, it would indeed be a wonder why they should not have lived to a good old age.

"But we citizens of a city life are trying to live under very different conditions. Housed in unsanitary buildings; crowded into tenements, flats, and apartments; deprived of heaven's pure air and sunlight; compelled to breathe contaminated atmosphere indoors and outdoors; surrounded by bacteria of both kinds,—harmless and unwholesome,—we must rely largely upon expert sanitarians, whose practical knowledge can teach us how to live, to enjoy health, to prevent disease, and maintain hygienic environments."

Sunlight and free pure air are natural germicides, and are infinitely superior to any artificial substitutes. In the supply of these the modern city tenement-house fails most lamentably. The persistence of life in disease-producing micro-organisms is both amazing and appalling to those who approach the subject for the first time. No one yet knows what length of time will serve to destroy them, and dust, dirt, darkness, and dampness are their most loved haunts. Therefore too much stress cannot be laid upon perfect cleanliness in cellars, which, if not kept dry and free from household waste, may become veritable poison-beds for ourselves and our children. Clothing and textile fabrics should be frequently beaten and exposed to the air and sunlight. Carpets, when being swept, should be sprinkled with moist tea-grounds to prevent dust from rising. Feather-dusters and whisk-brooms are pronounced to be "domestic abominations." In their stead damp cloths should be used for removing dust. Roof-gardens are recommended. All wastes of whatever kind should speedily be removed, and the best way of doing this is by burning them up if this be practicable. All textiles, except such as are needed for the comfort of the patient, should be removed from the sick-room, as precaution against possible spread of infection, whenever a suspicion exists that a disease may possibly turn out to be of this nature. Further and minute directions for sanitation in case of the invasion of infectious diseases are given. A mass of sanitary information is compressed into the limits of this paper, which ought to be widely disseminated.

Holophane Globes.

THESE globes are a new invention for use with lights of high candle power, such as is afforded by the Welsbach system of lighting, and may also come in with acetylene lighting now in its very beginnings. The London Journal gives an account of this invention, which is due to Messrs. Blondel and Psaroudaki, and in doing so says that it appears to remove the chief obstacle to the complete popularity of all commercial high power lamps and light sources of high intensity and small surface.

"There are no illustrations available as yet whereby we might show the holophane globe in operation; but we can testify to the fact that it has the appearance, when inclosing an incandescent gas or electric-lamp, of a vase filled with light, brilliant yet soft. The actual burner or filament cannot be discerned. The desideratum of the advocates of diffusion in lighting is thus in effect supplied, although the source of light is a mere line or spot. We are assured that it is the same with the electric arc light. As for the loss entailed by all this reflection and refraction, it is certified by M. de Nesville to amount in the case of an arc light to from 9 to 13 per cent. As this observer remarks, there is no other kind of globe in existence capable of realizing such a diffusion of light, and at the same time presenting such a uniformity of effect. Seeing that the loss of light by transmission through clear glass is 8 to 10 per cent., the claim for the holophane globes that they do their special work for about 4 per cent. of loss is well established.

"The principle of the holophane moulding is soon explained. The interior surface of the globe is formed into vertical grooves, which are so shaped as to spread out horizontally the rays proceeding from every part of the light source. They are thus moulded to one regular section. The mouldings on the outer surface of the globe are horizontal, and have the effect of distributing the emergent rays in the vertical sense; and inasmuch as the light may be required in some instances to be cast downward, and in others to be equally dispersed, the angles of the outside grooves are modified accordingly. This is a very different thing from the unscientific cutting seen in ornamental cut glass globes, which does nothing for the diffusion of the light." The analogy of this arrangement of facets to that of the Fresnel lens is apparent.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Heating and Ventilation.

*30837. Heating and Ventilating Tall Buildings.—Problems for the Architect, Builder, and Owner. Ill. Leicester Allen (Eng Mag–June.) 3000 w.

30849. Testing Fire Brick. Charles Ferry (Ir Age–April 11.) 2200 w.

30951. Hot-Water Heating of a Mission House. Ill. (Eng Rec–April 13. 900 w.

*31002. Steam and Hot-Water Fitting. F. G. Perkins (Dom Eng–April.) 3600 w.

*31003. Combination Heating. John Millar (Dom Eng–April.) 3500 w.

*31004. General Directions for Furnace Work. George D. Hoffman (Dom Eng–April.) 1500 w.

31058. Heating and Ventilation of the South Evanston School. Ill. (Heat & Ven–April 15.) 1000 w.

31059. Fan-Blowers. Ill. Souffleur (Heat & Ven–April 15.) 600 w.

31060. Comparison of Steam Heating Boilers. Stephen Quentin Hayes (Heat & Ven–April 15.) 2200 w.

31086. The Proper Location of Radiators. W. H. Pennell (Met Worker–April 20.) 1000 w.

31115. Steam and Hot Water Heating. F. G. Perktns (Mas St Fit–April.) 4000 w.

31116. Greenhouse Heating. Extract from Paper by A. H. Douglas (Mas St Fit–April.) 800 w.

31245. Hot Blast System of Heating—Garden City Fan Company, Chicago (Sta Eng–April.) 400 w.

31471. Hot-Water Heating and Ventilation of a Church. Ill. (Eng Rec–May 4.) 800 w.

†31491. Test of a Heating System. L. P. Breckenridge (Tech–No. 9.) 2000 w.

31543. Hospital Ventilation. Morrill Wyman (Am Arch–May 4) 3000 w.

Landscape Gardening.

30861. A Notable Park Project in New Jersey. Editorial (Gar & For–April 10.) 1200 w.

31038. Public Reservations in the State of New York (Gar & For–April 17.) 1000 w.

31456. Paths and Roads. From Gardening World (Land Arch–Jan.) 1400 w.

Plumbing and Gas Fitting.

31174. Soil-Pipe Joints. Ill. Grayson (San Plumb–April 15,) 2800 w.

Miscellany.

*31001. Sanitary Engineering. Abstract of Lecture by William Paul Gerhard (Dom Eng–April.) 900 w.

†31104. Sanitation. C. W. Belden (In Arch–April.) 2200 w.

†31478. House Sanitation. Moreau Morris (San–May.) 5000 w.

Serials.

26907. Hot Water Heating and Fitting. J. L. Saunders (Heat & Ven–Began Nov. 15, 1894—5 parts to date—15 cts. each).

29334. Technical Subjects that Plumbers Should Know. F. Dye (*Plumb & Dec*–Began Feb.—3 parts to date—30 cts. each).

ELECTRICITY

Cost of Niagara Power to Consumers.

THE *Electrical World* (March 9) states that a conference was held on February 21 between a representative of the Niagara Falls Power Company and a committee of municipal representatives of Buffalo, in reference to the proposed undertaking for the transmission of power from Niagara to Buffalo. On the part of the Niagara company it was stated that it would not be possible to economically deal with an amount less than 10,000 h. p., but that the company would undertake to effect the transmission and distribution of power to this amount, provided a proper franchise was granted. The company would refuse consent to the fixing of a maximum or other price for power within the city; the consumer would find adequate protection against excessive charges in the fact that, unless electric power costs less than steam power, it will not be used. It being proposed by some that the city should buy the power from the company and distribute it to the consumers, the Niagara company offered three propositions: (1) to sell 10,000 undeveloped h. p. on the lands of the company at $10 per h. p. per annum (24 hours), as is now done in the case of the Niagara Falls Paper Co.; (2) to sell the same amount of power from the turbine-shafts at $13 per h. p. per annum; or (3) to sell 10,000 electrical h. p. from the company's generators at $18 per h. p. per annum, in the form of a 2000-volt alternating current. The somewhat remarkable statement was made that "the company cannot name a price for electrical power transmitted to the Buffalo city line, as in the question of transmission are involved the uncertainties of the losses and cost of operation and maintenance." Inasmuch as the company claims to own three separate rights of way over private land from Niagara to Buffalo, it is not easy to see precisely where the question of indefinite losses and uncertainty of cost of transmission and maintenance comes in. As a problem of electrical engineering, it certainly does not appear to present any very serious difficulties in the light of the abundant experience gained in such matters within the past 5 years.

Measurement of Artificial Illumination.

THE ELECTRICAL WORLD (March 9) prints a paper read before the recent meeting of the National Electric Light Association, by Professors E. J. Houston and A. E. Kennelly, in which the authors point out that the question whether or not a given area is sufficiently lighted cannot be so well determined from a knowledge of the number and grouping of the luminous sources and their candle-power as from a method of actually measuring the quantity of light received per unit of area by the particular surface whose degree of illumination it is required to know. For example, in street-lighting a certain minimum intensity of illumination is required, which may be more satisfactorily determined by an actual measurement of the minimum illumination than by computations depending upon a number of complex conditions, of which the photometrical intensity of the separate sources employed is only one. Such a method of measurement would remove a source of great annoyance both to electrical engineers and to municipalities by avoiding occasion for discussion of the actual candle-power of the arc-lights usually employed, since, if the contract provided that the illumination in any part of a lighted street should not be less than a certain minimum, it would only be required of the electrical engineer that he should install such lamps as will, with the spacing employed, give the minimum illumination contracted for. The authors describe a portable apparatus which they had devised for the purpose of making such measurements, the operation of which depends upon the fact that a certain intensity of illumination is required to render a definite object, such as a printed slip, when viewed at a definite distance, clearly legible to the eye. A movable shutter operated by a milled-headed screw varies the quantity of light admitted through a small window to the test-object, and the corresponding intensity of illumination is read from a scale graduated in terms of the lux or candle-meter. It is stated that the apparatus requires no particular skill in use, and can readily be employed by an inexperienced observer. There can be no doubt that some instrument of this kind is an important desideratum in the outfit of an electrical engineer, and it would seem as if this apparatus, in spite of certain criticisms passed upon it by well-known experts, might serve its intended purpose very satisfactorily.

A Study of Electrolysis.

THE ELECTRICAL WORLD (March 23 and 30, and April 6 and 13), contains a series of papers by W. Stuart-Smith, in which the author gives the results of an elaborate investigation made by him last year in behalf of the San Francisco Gas Company, with the assistance of Mr. Frank P. Adams, electrician of the Stockton Electric Light Company, mainly for the purpose of determining what steps might need to be taken by companies owning buried pipes in order to prevent general corrosion by leakage-currents from electric railways. The pipes were uncovered and electrically tested in more than five hundred different places. Each test was continued for some little time, during the passage of from four to six cars, the changes due to the movements of the cars and their frequency being carefully noted,—a wise precaution, as by its means otherwise unsuspected peculiarities were discovered. The author justly criticises the utterly untrustworthy and misleading results which have been obtained by some experimenters by means of ammeter readings, of which he cites a number of typical examples, and gives reasons which appear conclusive for employing in his own work voltmeter readings only. The articles are accompanied by an excellent map showing the lines of electric railway in San Francisco, which serves to render intelligible the detailed *résumé* which is given of the result of a large number of measurements at different points mentioned in the text. It was discovered, among other things, that there is no real ground for the assumption frequently made that water-pipes are more liable to corrosion than gas-pipes, as the conductivity of a line of pipe of either kind is entirely determined by the joints, the body of the pipe itself having but little to do with the result. It was found that the numerous service crossings of the interlaced gas and water systems were extremely effective in distributing the current over a wide area; also, that for this reason the volume of current passing to and from the pipes at any one point was very small, and though, as stated, a large number of different places were excavated and examined, no signs of electrolytic action were found. The companies owning the pipes were accordingly advised that generally no danger need be feared on account of the potential relations observed, but that, should a point be found where a main or service pipe was corroded, the remedy would be to unite the gas and water systems by a conductor at that point. Mr. Stuart-Smith is of the opinion that, under the far more complicated conditions that exist in a network of conductors buried in moist earth, the broad assumption made by Mr. Farnham in his paper on telephone cable read before the Institute of Electrical Engineers, in which he took the ground that the conductors were in a dangerous condition when positive to the earth, is not altogether warranted. The results of the tests are so fully given by Mr. Stuart-Smith that any person who desires may follow and check them, and draw his own conclusions from the recorded phenomena. The gas and water companies of San Francisco are certainly entitled to great credit for undertaking to make so careful and thorough an investigation, and no less for permitting the details of the results to be thus freely published for general public information.

The Polyphase Motor.

THE London *Electrical Review* (April 5) has a paper by Rankin Kennedy on the induction motor, in which it is contended that the true method of studying the action of these machines is to regard them simply as transformers, and that the phenomenon of the rotating poles has nothing to do with the matter. Mr. Kennedy says that "the power is produced by the induced current occurring at a time and place where it acts along with the magnetic flux next following upon that flux which set the said induced current up,"—a statement which, though not couched in unexceptionable English, seems to go straight to the root of the whole matter. He severely criticises, and apparently with justice, such examples of the mathematical treatment of the subject as that contained in Lieut. Reber's paper read before the American Institute of Electrical Engineers last fall, but shows that Mr. Steinmetz has employed a method of mathematical investigation in harmony with his own views as above expressed. Anything which Mr. Kennedy writes on the subject of inductive effects from alternating currents is always worth reading; he began experimental work on the subject at an early date, and has kept at it constantly, and—what is better—he is one of those too rare theorists who experiment first and write afterwards.

Electric Conduit Railways.

The *Street Railway Gazette* (April 13) has an illustrated description of the underground conduit system of distribution for electric railway service which has just been installed on the Lenox avenue line of the Metropolitan Traction Company in New York city, under the direction of Mr. F. S. Pearson, formerly engineer of the West End system of Boston. From the description it would appear that the builders have depended far more upon excellence of material and construction, and careful attention to minute details, than upon any particular novelty of design. The track and conduit are essentially the same as that employed in standard cable railway construction, doubtless with the idea that, in case the electrical scheme proves unsatisfactory, the ordinary cable may be substituted without unnecessary delay or expense. The only feature of the plan which calls for special notice is the type of electrical conductor employed, which consists, not of wires, but of 4½-in. iron channel-bars 30 ft. in length, insulated and supported at their adjacent ends, but not elsewhere, upon substantial pillars of soapstone. Manholes are provided at each point of support, these being the only points where trouble is likely to occur. It is not unlikely that a more efficient insulator may ultimately prove to be necessary, but, on the whole, it looks as if this system embodied elements of success. The pressure to be used in the first instance is only 300 volts. If the permanent operation of this line is as successful as there is reason to think it will be, it may have the effect of introducing an entirely new condition of affairs in respect to trolley cars in large cities. The practical results of the operation of this line will be awaited with interest.

A New Thermo-Electric Generator.

Ever since the discovery by Seebeck in 1831 that the direct conversion of heat-energy into electric-energy could be effected by applying the heat to the point of junction of two dissimilar metals, occasional efforts have been made to construct a practical apparatus, some of which have started out with an apparently fair prospect of success. The fatal defect has always proved to be in the instability of the apparatus; after a little use, it invariably gave way at the point of junction of the two metals. In the *Electrical Engineer* (May 1) Mr. H. B. Cox describes an apparatus which he has designed and constructed, in which the unlike members of the thermo-electric couple are alloyed into each other, as it were, at their abutting ends, so that there is no definite point of junction. A generator of this type is stated to have been in constant use for three years, without giving any indications of deterioration. The article is accompanied by an illustration of a small generator weighing 3 lbs., which is fitted to a gas-burner consuming 1½ cu. ft. per hour, and is said to give an electrical output of 5 volts and 5.5 amperes, or .037 horse-power. A larger generator, using coal for fuel, generates current, at a cost of one-fifth of a cent per lamp-hour, from coal at $4.50 per ton. If these results are capable of verification upon an extended scale, it is impossible to over-estimate the importance of Mr. Cox's discovery. It opens the way to nothing less than a complete revolution in our present methods of obtaining power from heat-energy. It is stated that the entire system of the Commercial Cable Company is to be operated by these generators as soon as possible, a test of several weeks having demonstrated their economy and efficiency to the entire satisfaction of the management.

High Pressure v. Low Pressure.

In the London *Electrical Review* not long ago Mr. Rankin Kennedy has a thoughtful and well-considered paper, in which he seeks in some measure to forecast the direction of future development of electrical distribution. He points out that the system which is now rapidly coming to the front is the dual or compound system, high pressure being used at the central station to feed local sub-stations, from which a low-pressure system of mains serves to supply the neighboring consumers. This, it may be noted, is also distinctly the tendency of the most recent practice in this country. Mr. Kennedy doubts, however, whether such a system presents any real advantages over others, in many of the places where it has been installed. "There arises"—he says—"a very nice question for engineers, as to how much is to be gained in any given case by the use of high-pressure feeders, and under what circumstances are the advantages of high pressure great enough to warrant its adoption?" It must be borne in mind that electrical energy in the form of a continuous current is much more generally useful than in the form of an alternating current. This fact has perhaps not hitherto been fully realized, for the reason that both kinds of currents are equally good for the purpose to which electrical energy is at present most largely applied,—that is, of lighting incandescent lamps. When a supply is first laid down, the difference in cost between a high-and a low-pressure system is much greater than it will be later on as the full load comes up, because at first the low-pressure mains are few and short and not heavily loaded; hence engineers find that they can make a start with much less capital outlay on the high-pressure system, and therefore it is adopted without sufficient consideration of the future. In this way Mr. Kennedy thinks that low-pressure plants are often unfairly and unfavorably compared with high pressure plants. It is only later on, when the cost of the added low-pressure mains can be taken into account, that a true comparison can be made. With an improved system of storage, the generating plants at present in use might supply seven times the present annual output. The advent of this improvement, Mr. Kennedy thinks, "would knock the bottom out of the whole alternating current plan." The great future of the alternating current, in his opinion, lies in transmitting large quantities of energy over long distances, by phasal systems, as at Niagara. He entertains no doubt of the ultimate success of luminescent lighting,—the secret of the fire-fly,—and indeed goes so far as to express his conviction that we already have the key to the solution of the problem. What seems to be most needed is a general interpretation of the meaning of the results and data bearing on the subject, which have already been accumulated by industrious investigators.

The Cost of Electrical Supply.

The actual cost of supplying electrical energy to consumers, especially in the form of light, is a matter about which there has already been a great deal of discussion, but in respect to which very much yet remains to be learned. Another problem closely related to this is that of the most equitable basis of charge to consumers, and it is one which presents a great many difficulties. In the London *Electrician* Arthur Wright has recently published a very instructive paper, in which he gives the results of the methods adopted by him at the station in Brighton, England, a town having some of the social and commercial characteristics of our own

Newport. Mr. Wright's general plan may be said to be that of charging a high rate per unit consumed, until each consumer's proper portion of the fixed charges has been reached (these latter amounting in the case of the Brighton station to 80 per cent. of total expenditure), and above that point, of making a material reduction. He points out that, were it not for the fact that only some 13 per cent. of the consumers use the light at all during 3 months in the year (an average of less than 1 hour per day), the present plant would be of ample capacity to supply the increasing business for at least 2 years, whereas, by reason of their existence, it is necessary to install additional plant to take care of the winter's load. The item of expenses includes really but two divisions, fixed charges and running cost, and hence, as Mr. Wright points out, it is necessary only to have two rates of charge for the consumer in order to obtain a perfectly equitable sliding scale of rebates, which, he assures us, involves but little more clerical work than a uniform price system. Mr. Wright insists strongly upon the superiority of a system giving rebates based on a consumer's actual use of the generating plant and conductors over one based on the more or less prolonged use of all the lamps installed. The former encourages the general use of electric light, while the latter has a contrary effect, and is, moreover, based on an unsound principle, as the preponderating fixed charges are not altered in any way by the proportion of the total number of lamps in a house which remain unlighted.

Electricity as a Profession.

In a pithy and forcibly-written article in the *Electrical World* (March 16) Frederick H. Ford expresses the opinion that the pressing demand at the present time is not so much for educated electrical engineers as for educated capitalists; men who are capable of understanding that it is better to employ those who know why things should be done and who will look after economy in the output than to hire cheap men and waste the salary of a good man in inefficient methods of working. "When capital has been so educated," says Mr. Ford, "and not until then, will the relation between work done and pay received by the [electrical] engineer compare favorably with that of the lawyer, the doctor, the writer, or the merchant." It is certainly true that at the present time the closing of many large electrical works on account of patent litigation or financial trouble has thrown out of employment a large number of electrical engineers of experience and ability, and the visible supply of this particular variety of talent is so much in excess of the demand that salaries have been forced down to a point absurdly out of proportion to the expenditure of time and money, to say nothing of hard work, which an electrical engineer must necessarily incur in fitting himself for the practice of his profession. This is a condition of affairs that should receive the serious attention of all young persons who are about to determine upon their vocation in life.

Danger from Alternating Currents.

In a communication in the *Electrical World* (March 23) Mr. W. D. Dickinson mentions several specific instances in which persons have received severe shocks, in one instance resulting fatally, from the secondary circuits of an alternating system, and states that in each case it was found upon subsequent investigation that a connection had been formed, usually by the action of lightning, between the primary and secondary circuits of a transformer. As the manager of an electric plant, these accidents have caused Mr. Dickinson much anxiety, and he anxiously inquires what means, if any, have been successfully employed by others for obviating the trouble.

Exasperating Electrification.

It is well known by experienced printers that the output of the press-room is greatly reduced, during cold, dry winter weather, by the annoyances and interruptions due to the undesired presence of static electricity in the paper which is being printed upon, as manifested in smutting, imperfect delivery, etc. A correspondent, writing in the *Electrical World* positively states that an effectual remedy has been found in a perforated steam pipe, which liberates a quantity of moist vapor immediately under the sheet of paper as it leaves the cylinder after being printed. Another correspondent says that, in another establishment, a current of warm air has proved an equally efficacious means of dispersing the troublesome static charge. If this is the case, printers generally will have good cause to thank the originator of the device, whoever he may be.

Electric Transmission at High Voltages.

A WRITER in the *Electrical World* recently made the statement that there is at present no electrical plant in operation at a pressure higher than 10,000 volts. In reply to this, Mr. Emil Kolben of the Oerlikon Works, near Zurich, Switzerland, writes to the same journal that the power-plant by which those works are driven has been in successful and continuous operation for more than three years at an effective pressure of 13,000 volts. He further says that no serious trouble has been experienced with the insulation of the line, which is bare copper supported on large porcelain insulators of a special type. This is a very important piece of practical information.

THE *Electrical World* (March 23) publishes specifications drawn up by the National Academy of Sciences, in accordance with the act of congress of July 12, 1894, establishing and defining certain units of electrical measurement, for the practical reproduction of ampere and volt. The directions are minute and specific.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Lighting.

30843. A Modern Electric Light Station.—First District Station of the Edison Electric Illuminating Company, of Brooklyn. Ill. (Elec Wld-April 13.) 900 w.

30852. Electric Lighting of the New York and Brooklyn Bridge Cars. Ill. (Elec Eng-April 10.) 2400 w.

30854. The Arc Light for Municipal Street Purposes. Ill. I. C. Wood (Elec Eng-April 10.) 2300 w.

30866. The Manufacture of Incandescent Electric Lamps. Ill. (Sci Amer-April 13.) 800 w.

30878. Specifications for Street Lighting by Arc Lamps. William Pierson Judson (Eng News-April 11.) 1400 w.

30889. Reception of the Edison Electric Illuminating Company, of Brooklyn. Ill. (Elec Age-April 13.) 1000 w.

*30974. The Coupling of Dynamos for Arc Lighting. W. H. Lea (*Elec Eng*-April 5.) 1200 w.

30999. The New Station of the Citizens' Electric Illuminating Company, Brooklyn, N. Y. Ill. (Elec Rev-April 17.) 800 w.

31035. Electrical Enterprise in California.—The Los Angeles Electric Company. Ill. George Heli Guy (Elec Eng-April 17.) 1800 w.

31062. An Office Building Lighting Plant. Ill. (Elec Wld-April 20.) 1000 w.

*31080. Electric Lighting for Large Buildings. George White Fraser (Can Arch-April.) 1200 w.

31083. The Improved Ball System of Electric Arc Lighting. Ill. F. B. Widmayer (Elec Age-April 20.) 1800 w.

*31113. Sodium in Electric Light Boxes.—Report of Committee of Investigation (*Gas Wrld*-April 13.) 1200 w.

31186. Underwriters' Rules. William A. Anthony (Elec-April 24.) 1300 w.

31187. Practical Wiring Specifications. A. E. Dobbs (Elec Eng-April 24.) 900 w.

31201. The Heat of the Electric Light. C. C. Haskins (W Elec-April 27.) 800 w.

*31283. The Photographic Testing of Projector Reflectors. Ill. V. Tchikoleff (*Elec Eng*-April 19.) 700 w.

*31514. The Electric Lighting of the Houses of Parliament. Ill. (*Eng*-April 26.) 2700 w.

*31531. New Methods in Central Stations—Belfast and Leicester. Ill. (*Elec Rev*-April 26.) 600 w.

31574. Polyphase Currents for Lighting and Power in a Factory. M. P. Boucherat (Elec Rev-May 8.) 1000 w.

31575. An English Municipal Lighting Plant—Manchester, Eng. (Elec Rev-May 8.) 1500 w.

31604. Louisville Auditorium Plant. Ill. (W Elec-May 11.) 1500 w.

Power.

30883. Water-Power Development with Electric Transmission, Folsom, Cal. Ill. (Eng News-April 11.) 800 w.

*30932. The Early History of the Polyphase Motor. Rankin Kennedy (*Elec Rev*-April 5.) 1200 w.

31040. Distribution of Power from Niagara. Ill. Frank C. Perkins (W Elec–April 20.) 3400 w.

*31102. The Cost of Electric Energy for Private Installations. Editorial (*Engng*–April 12.) 2000 w.

*31106. Transmission of Power by Electricity. W. C. Mountain (*Col Guard*–April 11.) 5400 w.

31169. Electric Apparatus in Use for the Construction of the Jetties of the Port of Bilbao. Ill. P. H. Van der Weyde (Mnfr & Builder–Dec.) 500 w.

31217. Power Cheaply Produced (Safety V–April 15.) 700 w.

*31258. Recent Papers on Dynamo Design. Editorial (*Electr'n*–April 19.) 1500 w.

31401. The Cox Thermo-Electric Generator for the Conversion of Heat Directly into Electrical Energy. Ill. Harry B Cox (Elec Eng–May 1.) 2800 w.

31402. The De Bovet System of Electric Canal Boat Traction. Ill. (Elec Eng–May 1.) 400 w.

31449. Power Consumed on Electric Railways. G. Pellissier (Elec Age–May 4.) 1400 w.

†31570. Dynamo and Motor Design. Gano S. Dunn (Jour Fr Inst–May) 1500 w.

31576. An Electrical Ferry Service. Ill. (Elec Wrld–May 11.) 700 w.

31585. The New Power House of the Columbus Central Railway Company. Ill. (Elec Ind–May.) 1600 w.

Telephony and Telegraphy.

30844. The Perrin, Bonta and Cole Telephone Patents. Ill. (Elec Wld–April 13.) 1800 w.

31000. Telephones in England (Elec Rev–April 17.) 1000 w.

31037. Long-Distance Microphone Transmitter . Editorial (Elec Eng–April 17.) 1000 w.

31168. Telegraphing Without Wires. Ill. (Mnfr & Builder–Dec.) 800 w.

31176. Automatic Telephone Exchange.—Constructed by Deckert and Homolka. Ill. Victor M. Berthold (Elec Rev–April 24.) 900 w.

31376. American Bell's Weakness. Facts and Figures Concerning the Present Status of the Telephone Business (Elec–May 1.) 4000 w.

31446. Reorganization of the Mutual Automatic Telephone Company. From Philadelphia Ledger (W Elec–May 4.) 1000 w.

31476. Long Distance Signalling. A Scheme for Sending Heliograph Messages from Washington State to Mexico (Bos Jour Com–May 4.) 500 w.

Miscellany.

*30838. Power, Light and Heat in City Blocks.—The Combination of Electricity and Steam. Ill. J. E. Talbot (Eng Mag–June.) 3000 w.

30845. Armature Reactions in a Simple Alternator Compared with that in a Multiphase Generator. Ill. Ossian Chrytraeus (Elec Wld–April 13.) 500 w.

30860. A Pioneer in Electricity—Sir Francis Ronalds. John Syme (Elec–April 10.) 2800 w.

30886. Variation of Internal Resistance of a Voltaic Cell with Current. Henry S. Carhart (W Elec–April 13.) 800 w.

30887. Proposed Board of Electrical Examiners for Chicago (W Elec–April 13.) 1800 w.

*30933. On the Diselectrification of Air. Ill. Lord Kelvin, Magnus MacLean and Alexander Galt (*Elec Rev*–April 5.) 800 w.

†31010. Resonance in Alternating Current Lines. Edwin J. Houston and A. E. Kennelly (Tr Am Inst Elec Eng–April.) 6500 w.

31063. Patents for Electrical Inventions (Elec Wld–April 20.) 2400 w.

*31122. On the Question of Dielectric Hysteresis. Ill. Alfred W. Porter and David K. Morris (*Elect'n*–April 12) 1200 w.

*31127. Dr. Keith on the "Electrolysis" and "Analysis" of Elementary Bodies, with Illustrations of Criticism. Desmond G. Fitzgerald (*Elec Rev*–April 12.) 1600 w.

31164. Contribution to a Theory of Synchronous Induction Motors. Alexander Rothert (Elec Wrld–April 27.) 1800 w.

31165. The Galvanometer in Practice. Ill. Louis Denton Bliss (Elec Wrld–April 27.) 1200 w.

31175. Dynamic Apoplexy.—True Cause of Death by Electrification. Ill. J. Mount Bleyer (Elec Rev–April 24.) 1400 w.

31185. The Varying Cost of Electricity. Arthur Wright (Elec–April 24.) 1200 w.

31192. The United States Units of Electrical Measure (Sci Amer Sup–April 27.) 1500 w.

31212. The Legal Aspects of Electrolysis. (Abstract.) Henry C. Townsend, in Cassier's Mag. (Elec Age–April 27.) 1500 w.

*31256. Note on the Force Experienced by Iron-Embedded Armature Conductors. W. B. Sayers (*Elect'n*–April 19.) 900 w.

*31257. The Electrical Industry in London. Guido Semenza (*Elect'n*–April 19.) 2700 w.

*31259. On Supposed Magnetic Fatigue. Albert Campbell and R. P. Lovell (*Elect'n*–April 19.) 450 w.

*31278. The Force Acting at the Surface of Separation of Two Dielectrics (*Elec Rev*–April 19.) 450 w.

*31281. Material for Wire for Rheostats for Strong Currents. K. Strecker (*Elec Rev*–April 19.) 600 w.

*31282. On the Law of the Dissipation of Energy in Dielectrics under the Action of Electric Fields of Feeble Intensity. (Abstract.) Riccardo Arno (*Elec Rev*–April 19.) 700 w.

31368. The General Electric Company's Porcelain Factory at Schenectady, N. Y. Ill. (Elec Rev–May 1.) 1500 w.

31369. The Scientific Foundations of Electrical Engineering. F. G. Baily (Elec Rev–May 1.) 2000 w.

31370. Experiments with Electric Waves. Alfred G. Dell (Elec Wrld-May 4.) 700 w.

31371. On the True Dimensions of the Electrostatic and Electromagnetic Units, and on the Right Use of the Terms Intensity, Strength, Force and K. Reginald A. Fessenden (Elec Wrld-May 4.) 2000 w.

31375. General Electric's Third Annual Report (Elec-May 1.) 900 w.

31447. Electricity at the Atlantic Exposition. H. M. Atkinson (W Elec-May 4.) 1400 w.

31448. Action of the Electric Current on Fused Sulphurets. Jules Garnier (W Elec-May 4.) 600 w.

31450. Local Action in Accumulators. G. Darrieus (Elec Age-May 4.) 1500 w.

31477. How Lightning is Kindled (Bos Jour Com-May 4.) 500 w.

†31486. Some Experimental Data on the Design of Electro-Magnets. Ill. William Esty (Tech-No. 9) 7800 w.

*31515. The Use of Electricity for Cooking and Heating. Ill. R. E. Crompton, with Discussion (*Jour Soc of Arts*-April 26.) 7000 w.

*31536. A Magnetic Tester for Measuring Hysteresis in Sheet Iron. Professor Ewing (*Elec Eng*-April 26.) 4200 w.

*31558. Safety Precautions in Connection with Underground Mains in Berlin. From paper by Dr. Martin Kallman (*Elect'n*-April 26.) 1200 w.

†31568. Recent Advances in Electro Chemistry. Joseph W. Richards (Jour Fr Inst-May.) 9500 w.

†31569. Electricity Directly from Coal. Alfred H. Bucherer (Jour Fr Inst-May.) 1500 w.

31577. Galvanometer Construction at Lehigh University. Ill. Edwin E. Fisher (Elec Wrld-May 11.) 2000 w.

31583. Non-Magnetic Electric Devices. Ill. W. E. Irish (Elec Eng-May 8.) 2500 w.

Serials.

22131. The Incandescence Lamp. A. Bainville (*Elec Rev*-Began May 11, 1894—9 parts to date—30 cts. each).

23866. Electrodynamic Machinery. Edwin J. Houston and A. E. Kennelly (Elec Wld-Began July 21, 1894—35 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (*Elec*-Began Oct. 5, 1894—30 parts to date—30 cts. each).

25907. The Alternating Current; Its Generation and Distribution. Ill. George D. Shepardson (Elec Ind-Began Oct., 1894—6 parts to date—15 cts. each).

26592. Electrical Power Transmission. Louis Bell (Elec Wld-Began Nov. 10, 1894—20 parts to date—15 cts. each).

27371. The Electric Light. Ill. Henry Stooke (*Ill Car & Build*-Began Nov. 23, 1894—23 parts to date—30 cts each).

29156. Technical Telegraphy Papers. Ill. James Bell and S. Wilson (*Elec*-Began Feb. 1—11 parts to date—30 cts. each).

29158. The Construction and Use of Electrical Measuring Instruments. Charles H. Yeaman (*Elec*-Began Feb. 1—12 parts to date—30 cts. each).

30305. Electrical Condition of Buried Conductors Due to Leakage Currents from Electric Railways. W. Stuart Smith (Elec Wld-Began March 23—4 parts to date—15 cts. each).

30674. Gas Batteries. Ill. C. J. Reed (Elec Wld-Began April 6—2 parts to date—15 cts. each).

30696. Electric Power Transmission. Ill. T. H. Leggett (From Trans. Am. Min. Eng.) (Min & Sci Pr-Began March 30—Ended April 6—2 parts—15 cts. each).

30799. The Future of the Steam Engine. Foree Bain (Elec Ind-Began April—2 parts to date—15 cts. each).

30853. Classification and Selection of Lighting Systems. Francis B. Crocker (Elec Eng-Began April 10—Ended April 17—2 parts—15 cts. each).

30859. The Tesla Two-Phase System. Nelson W. Perry (Elec-Began April 10—Ended April 17—2 parts—15 cts. each).

30872. Telephony. V. Wietlisbach (Elec Engng-Began April—1 part to date—15 cts).

30938. Lighting, and Electric Lighting as a Business. George White Fraser (Can Elec News-Began April—1 part to date—15 cts).

30939 Dynamo Design. (Extracts.) E. B. Merrill (Can Elec News-Began April—1 part to date—15 cts).

30973. Electric Mains in Paris. Ill. A. Monmerque (*Elec Eng*-Began April 5—2 parts to date—30 cts. each).

30975. Effective Electric Lighting. Ill. W. Perrin Maycock (*Elec Eng*-Began April 5—Ended April 12—2 parts—30 cts. each).

31166. Curves for Winding Magnets. Harrison H. Wood (Elec Wrld-Began April 27—2 parts to date—15 cts. each).

31184. Opportunities in Electrical Engineering. A. A. Atkinson (Elec-Began April 24—2 parts to date—15 cts. each).

31188. Submarine Telegraph Cables. Ill. Samuel Trott (Elec Eng-Began April 24—Ended May 8—3 parts—15 cts. each).

31284. Electric Lighting of Trains. R. W. Weekes (*Elec Eng*-Began April 19—1 part to date—30 cts).

31344. Practical Telephony. Ill. James Bell (*Elec*-Began April 19—2 parts to date—30 cts. each).

31530. Alternating and Interrupted Electric Currents. Report of lectures by George Forbes (*Elec Rev*-Began April 26—1 part to date—30 cts).

31586. Factory Practice in the Design and Construction of Dynamos. Ill. C. E. Woods (Elec Ind-Began May—1 part to date—15 cts).

INDUSTRIAL SOCIOLOGY

The Influence of Workmen-Shareholders in Industrial Control.

It has been asserted that the scheme of admitting workmen to a share, not only in the pecuniary interest, but also in the control, of large industries would be, as a rule, fatal to the prosperity of such industries. Evidently such a proposition can only be effectively proved or refuted by facts such as advocates of either view have up to a recent date been unable to furnish. This state of things no longer exists. Experiments in admitting workmen to a share in control have been made, and the results have removed this contention from the realm of conjecture to that of evidence. Such evidence we find in *Journal of Gas Lighting* (April 23), in the form of testimony culled from the minutes of evidence taken by group C of the (English) labor commission, being the testimony of Mr. George Thompson, managing director and chairman of the firm of Messrs. Thompson and Sons, Limited, Woodhouse Mills, Huddersfield, England.

"Mr. Thompson has 30 years' experience of his trade; and his company employed 140 work-people. He told the commisioners that, in addition to the wages, the firm had a profit-sharing scheme, under which 80 per cent. of the work-people became copartners and shareholders in the concern. Mr. Thompson's statements as to the effect of the scheme upon the participants are a revelation for those capitalists who are unwilling to ascribe even common honesty to British workmen when uncontaminated by imported socialistic poison. In reply to Mr. Mawdsley (we quote from the official notes), the evidence ran as follows:

"'(Q. 7136.) Have these working-shareholders any one of their number on the directorate?'—'Yes; they could not be on the directorate unless they were holders.' (Q. 7137.) 'Are any of the directors taken from the ranks of the workmen?'—'Yes; three are taken from our own workmen, and three others (at present we have lost two by death) are representatives of the workmen outside.' (Q. 7138.) 'Have the directors any power in controlling the business of the company,—apart from yourself, I mean?'—'Not initiation exactly; but all great changes, important orders of machinery, and so on,—all are discussed by them.' (Q. 7139.) 'What do they do when they discuss them? Do you decide on your own responsibility afterwards whether you will accept their suggestions or not?'—'No; I think there has never been a case of that kind.' In answer to further questions, witness said that, out o seven actual directors,—there being two death-vacancies waiting to be filled at the next annual meeting,—three were workmen in the establishment and three others were workmen outside. The board meetings are held monthly, and there are occasional meetings of what is called the mil committee, composed of the chairman and the three workers in the mill, who report to the full board. Question 7160, by Mr Courtney, ran as follows: 'And you have never had any difficulty between yoursel and your fellow-directors?' The answe was: 'Never; we have occasionally smal differences of opinion, but we have neve had any trouble whatever. I think one o the pleasantest experiences I have had i working with my committee in this matter. I have only omitted one meeting fo the five years that we have been in existence.' Much of the witness's evidence was addressed to showing the difficulty o improving a trade that happens to b largely affected by changes of fashion."

One of the publications of the Labo Association is a pamphlet on the "Exhibition of Coöperative Productions at th Crystal Palace last August," from which the further facts stated below and bearing upon this subject are gathered.

The Alcester Coöperative Limite started in a very small way in 1889. Thi is described as a venture in an extremel difficult trade, and under the rules the committee includes "two workers." The Bristol Pioneers' Boot and Shoe Productive Society has working members eligible for the committee. Brownfield's Guild Pottery Society, Limited, appears to be managed by the workers. The Burnley Self-Help Cotton-Spinning Manufacturing Society, Limited, is administered by a committee elected from the workers. Of the Coventry Coöperative Watch Manufacturing Society, Limited, it is stated that "the governing body is a committee consisting almost entirely of practical watchmakers, and they have directed the society well." Many other similar instances might be cited, among the most important being the Leicester Coöperative Boot and Shoe Manufacturing Society, Limited, secretary and committee all elected in general meeting by the workers themselves out of their own body. Those who desire further information upon this and cognate subjects are referred to Mr. Blanford's pamphlets and other publications of the Labor Association, including the monthly periodical entitled "Labor Copartnership," which is a record of the results of the working of over a hundred societies, doing a trade of £1,300,000 a year, whose workers share in profit, capital, and control.

The *Journal of Gas Lighting* thinks the application of this system to the gas industry would present fewer difficulties than have been encountered in the instances cited, and advocates a trial of it, among other things remarking that "a beginning must be made with gas undertakings somehow, if this industry is not to remain outside the operation of the reforming method of internal copartnership. It is not a method to be forced upon any undertaking, without the good will of both parties to the bargain of employment. But—and the point is a grave one—there is every reason why any advance of the kind should be made from above,—from the 'haves' for the benefit of the 'have-nots.' This is the way of English reforms; and it distinguishes them from revolutions. Not only political, but industrial, history is full of examples of concessions freely granted by those who had the power to give and to withhold,—not in response to clamorous demand, but in accordance with the promptings of an enlightened sense of the right."

Fallacies that Fool Fiatists.

THE reviews in this department are made with a view to indicate as far as possible the currents and counter-currents of thought upon social questions. Many an argument with which we can not agree appears in current discussions, but which is so presented that it cannot fail to arouse interest in important questions, upon which all well-meaning citizens will be forced to think for themselves before a settlement of the present unrestful condition of society can be reached.

One of the things that causes general uneasiness is the money question. Mr. I. W. Porter, in a letter to the editor of *Social Economist*, voices this uneasiness when he says that "our government is getting into deep trouble, while the industries and commerce of the country are well-nigh paralyzed, because the laws of the country are not obeyed." Of course the claim that silver dollars are full legal-tender money is here referred to. Upon this assertion Mr. Porter threads a string of questions, to which the editor makes reply, each of the "fallacies that fool fiatists" which he enunciates, and which are hereinafter stated, referring to some direct or implied interrogatory in Mr. Porter's letter. This correspondent begins his letter with the allegation that "the fatal defect of all the plans for relieving the country by currency laws, if we except Mr. St. John's and General Warner's, is that they ignore the law of legal tender, and appear framed entirely in the interest of the banks."

In replying to this letter. *Social Economist* first discusses what it calls "the legal-tender fallacy," and follows with no less than eight more "fallacies,"—to wit, (2) "the depression or low-prices fallacy"; (3) "the cheap-money fallacy"; (4) "the interest-gorgon fallacy"; (5) "the flexible-'yard-stick' fallacy"; (6) "the follow-France' fallacy"; (7) "the 'fiat-money' fallacy": (8) "the 'greatness-of-government' fallacy"; and (9) "the decline-in-prices fallacy." We will try to indicate the line of argument whereby it is sought to prove that these notions are really fallacies.

(1) Of the legal-tender law it is said that there is a higher law. "'Thou shalt not steal' by paying a dollar of debt with 50 cents of value." And it is intimated that sticklers for the legal-tender laws are doing the banks injustice by failure "to recognize the fact that they" (the banks) "may honestly believe that, besides the legal-tender laws, there are laws of value or economic laws which are higher than legal-tender laws, and that one of these economic laws is that, if silver can be continuously produced at a cost of only eight to one, as compared with gold, and, when produced, can be freely coined at a nominal value of sixteen to one as compared with gold coin, then the value of silver coin, under free coinage, must fall to its cost of continuous production,—*i. e.*, the value of a silver dollar freely coined must fall to 50 cents in the United States, as it has fallen in Mexico. Believing this, and not desiring to see American standard dollars sink to half their value, are bankers not bound in honor as well as interest to oppose free coinage of silver, under a law of economics which is higher than the legal tender law,—viz., 'Thou shalt not steal' by paying a dollar of debt with 50 cents of value"?

(2) Of "the depression or low-prices fallacy" it is remarked "that in the decade between 1883 and 1893, according to reports of our director of the mint, the stock of standard silver coin in use in the commercial world has been increased by $1,300,000,000, or by fully half as much in 10 years as the whole silver coinage of the previous four centuries had accumulated. About $580,000,000 of this addition has been made in the United States, and is represented by United States certificates payable in silver. If plenty of standard silver could help put up prices of merchandise, labor, or land, you have had it. . . . . You might as well stand under Niagara's torrent and complain that you are kept dry by the predictions of the weather bureau of the government as live through the torrential and diluvian flood of standard silver coin that has drenched the whole financial world since silver was demonetized, and claim that the laws against free coinage have neutralized the inflating effect on prices which ought to ensue from its actual coinage in such unprecedented volume. All the silver combined which was coined in the United States or in the world during the century preceding the demonetization of silver was only about one seventieth part of the coinage of 15 years past."

(3) Regarding the fallacy of cheap money: "The public treasury has been getting all the benefit which could accrue from substituting treasury notes for gold and silver coin as the basis of our commerce for thirty years. It is this which now brings the treasury into the trough of the sea, where it cannot, even by the issue of new bonds at the rate of $100,000,000 a year, keep its gold in the treasury with which to hold up its treasury notes. When it ceases, they will be quoted at 50 cents on the dollar. The treasury is now the only debtor in the country that can be called on to pay coin, and it can only a few months longer pay gold coin. . . . As the apparent success of the greenback helped to impair the value of silver, to issue more greenbacks now as a means to raise the value of silver is to use the hair of the same dog to cure the bite."

(4) As to the "interest gorgon," it is responded that "rates of interest bear the proportion to the earnings of industry of one to four." "If, therefore, interest would eat up the value on which the principal is loaned in twelve years, wages would consume the capital that employs it in three years. The average annual increase or earnings on all the capital in the country working conjointly with all the labor is 24 per cent. Therefore there is no more danger that interest will swallow up wages than there is that one of the four sides of all the parallelograms in the world will swallow up the other three sides."

As to fallacy (5), it is replied "that

nobody desires that money itself shall be flexible, but that the volume or quantity of it in use should be flexible." "Merchants do not want yard-sticks of india-rubber with variable length, but what they do want, and ought to have the privilege of getting, is just as many yard-sticks as they need to use in their business." It is argued further that, if the government issued yard-sticks not otherwise obtainable and "made every yard-stick a promise by the government to exchange it for a yard of velvet," there would necessarily result a limit to the number of yard-sticks obtainable by merchants.

(6) As to the assertion that France has 600,000,000 francs "of legal-tender paper money in circulation," it is answered that, so far from this being the fact, she has not even "a cent's worth." "The only paper notes circulating as currency in France are the notes of the Bank of France, which has a branch in each of the eighty-seven departments of France. It is customary for the government to impart the quality of *cours forcé*, or legal tender, to the notes of the Bank of France in periods of public exigency (war), but to withdraw it on the return of normal conditions. . . . France is aided in maintaining silver by the fact that she has no treasury notes to maintain. She makes her payments, therefore, largely in silver, and the public creditor must take whatever proportion of his pay in silver she offers. But, if she were a bankrupt debtor, carrying tons upon tons of demand notes which she could not pay, her case would be different."

(7) As to fiat money, it is urged that "government never undertakes to supply the people with money except when it has no money itself. All that its money, therefore, can represent at any time is a hole left by an explosion." This point is elaborated, but we must get to the end.

(8) To "the 'greatness-of-government' fallacy" the answer is that, while the government receives and pays out annually about $350,000,000, "the bank clearings in 1892 were $61,535,493,426"; and that, "though they are now about $17,000,000,000 less, it is plain that the degree in which 'means of payment' are supplied by bank credit is sixty-fold the degree in which they are supplied by government payments."

Lastly (9), as to the decline in prices, it is retorted that "it is not all values that have declined, . . . but only the value of products," while "the value of the means of production, . . . including land, labor, and capital," has been advancing. This argument is also elaborated, but cannot here be further followed out.

The Silver Question.

A PAMPHLET of seventy-five pages, entitled "The Silver Question," has been sent to us from London. It contains an essay by George Jamieson, the British consul-general at Shanghai, to whom was awarded the bimetallic prize of £50 offered by Sir Henry Mersey Thompson for a paper which should point out most clearly (1) loss and injury sustained in England by the extraordinary rise in the value of gold during the last 20 years, consequent on changes in the laws regulating the use of gold and silver as money in various countries; (2) the tendency to the transfer of manufacturing industries to "silver-using countries" thus created, the result having been a rise in the silver prices of British manufactured articles and a "fall in their gold-price"; (3) that "this divergence" of gold and silver values must inevitably "lead to the ruin" of many British industries, and, by the substitution of cheap for "more highly-paid labor," "the throwing out of employment of tens of thousands of workmen."

This prize essay is supplemented by two others,—one by Thomas Holyoake Box, of Yokohama, the other by David Octavius Croal, of London, the whole being introduced by a preface written by Sir Henry Mersey Thompson, explaining the reason for offering the prize, and the reason governing its award. It will be possible only to indicate the leading points in the principal thesis.

(1) "Prices (wholesale) of nearly all commodities have fallen in gold-using countries. This fall coincided roughly, step by step, with the fall in the gold value of silver up to the end of 1892. Since that

date silver has fallen more rapidly than commodities, but the latter appear to be still falling." (2) "Wages, rents, and taxes in gold-using countries have not varied, or have varied only within narrow limits, due to temporary and local causes. Agricultural rents should, perhaps, be excepted ; but these are subjected only to periodical revision." (3) "Retail prices (into which wages, rent, and taxes enter largely) have not fallen at all." (4) "Prices (wholesale) of all commodities in silver-using countries have remained approximately steady during the period, and this whether the articles were produced in this country itself or imported. In the case of articles imported from gold-using countries, however, there has been, since the middle of 1893, a rise in silver prices, corresponding to the divergence between silver and commodities noted in No. 1." (5) "Wages, rent, and taxes have not varied in silver-using countries, or have varied only within narrow limits, and from causes unconnected with the relation of gold to silver." (6) "Retail prices in those countries have not varied, except in the case of articles purchased at retail in gold-using countries, which have risen in proportion to the rise in gold."

These propositions are fortified by the citation of a number of authoritative statistical publications. The causes assigned for alterations of prices are (1) "cheap ocean freights and a lessening of cost of production, through improvements in machinery, new chemical discoveries, and other scientific advances"; (2) the appreciation of gold, consequent upon the demonetization of silver; and (3) "an enlarged area of supply consequent on the relative cheapness of silver to gold. As silver prices in Asiatic countries have not risen, the produce of those countries can be laid down in England at almost Asiatic prices." The lowest cost of transport and production could not have affected prices more than from 3 to 5 per cent., and to the two causes—appreciation of gold and increased area of supply—are attributed the changes in prices that have marked the two last decades. "By the breaking of the bi-metallic link silver-using and the gold-using portions of the world parted company." In the gold-using portions prices began to adjust themselves to the mass of gold in circulation, and in the silver-using portions prices began to adjust themselves in relation to the mass of silver in circulation. If the portions thus separated had been "approximately equal in wealth, population, and extent of commerce," serious disturbances of prices would not have resulted. But, being unequal in these respects, the superiority being on the side of the gold-using portions, prices conform in different countries to that part of the gold, or of the silver, which "has found its way into their circulation." The increase in area of production has at the same time been a potent factor in the cheapening of produce, especially that of the cereal class.

Though Oriental competition has hitherto been confined to coarser grades of goods, there is no reason for supposing that it will remain so, provided the present status of gold and silver as money remains to stimulate such competition. The paper is a very strong argument in favor of bimetallism.

The Aged Poor in England.

THE working of the English poor-law system as regards the aged poor is manifested in a report of the royal commission, which, while voluminous and elaborate, and loaded with statistics, *The Journal of Gas Lighting* (April 9) criticises as not containing "a single suggestion capable of being worked constructively with the object of removing a social condition which an awakened public conscience regards as a defect of our modern civilization." This criticism, however, is made against a shortcoming not unprecedented or altogether inexcusable, since to suggest a remedy for the existence of a class of "aged poor" except through a total reorganization of society would tax the profoundest of social economists.

The facts that the condition of this class is slowly improving under the present English poor-law system, and that it is gradually diminishing, appear to be established by the report, and are gratifying so far as they go. But the improvement and the diminution inferred from the statistics are so slight that they seem scarcely more than an indication of the tendency which, to become very sensible in its effects, must continue through a long period.

It has been charged that drink, idleness, improvidence, and other vices are responsible for the existence of this class; but the report holds that this is true of only a very small proportion of workhouse inmates. "It is admitted that a certain number of deserving aged poor are to be found in workhouses for reasons other than sickness or infirmity; but the general effect of the evidence taken by the commission distinctly tends to the conclusion that they are few in number. Workhouse inmates generally are not fair examples of the working population. They are the failures, not necessarily all from vice, but from vice, slackness, want of backbone, which have in various degrees combined to make them the 'hard bargains' of the industrial army."

There is a minority report signed by five of the commissioners. Of the majority report *The Journal of Gas Lighting* says that it "is a series of cold douches for amiable visionaries who permit their fancies to carry them off into all sorts of dreams respecting methods for alleviating the lot of the aged and deserving poor. Many such suggestions are given, only to be dismissed as objectionable or unworkable on one score or another; while at the same time the existing system is admitted to be unsatisfactory in precisely the respects to which the suggestions refer. Hence it is not to be wondered at that the government and many other people are disappointed with the result of the inquiry: government, because the report does not indicate any lines upon which legislation calculated to receive the support of the labor vote might be instituted; and benevolent persons, because the report hardly assists anybody, with a shilling to spare for the help of the poor in old age, to see a way to its judicious employment for this purpose."

"The minority blame the majority for inadequately dealing with all that portion of the report which is concerned with the suggested substitutes for, or accessories to, the poor law. It is certainly remarkable that the efforts actually being made by employers of labor to help their aged workpeople to live without coming upon the rates are not even cursorily mentioned in the report."

The number of the commissioners—fifteen—is thought to have been too large. One of five members would have been better, and "such a commission might with advantage be composed of a statesman, a lawyer, a financier, an engineer, and a physician. . . . Human wit and capacity fail before the immensity and complexity of the problem as a whole," and "the policy of attacking it in detail by beginning on the nearer side" is commended. The gas industry in England has already adopted this policy, and of the results of its efforts a hopeful view is taken. "We trust that, so far as the gas industry is concerned, the practicability of preserving good honest workers from dying as paupers will be demonstrated before the world, for the guidance of whosoever may take up the task of formulating a constructive policy, which proved to be quite beyond the powers of the late commission. There is no mystery about this matter; it is done, and has been done for years, by many gas companies; but the duty should be recognized by many more."

Hard Times and the Railway Employees.

In our department of Railroading for this month the effect of the hard times upon the great railway interests is revived with special reference to receipts, economies, dividends, and the enormous load thrown upon railway management by such commercial conditions. In the article therein reviewed ("Hard Times and the Railroad"—*The Peterson Magazine* for May) it is stated that "in June, 1893, there were 873,602 men employed on the railroads of this country. These men were divided almost equally between the active labor of administration and transportation and the conservative toil of reconstructing and repairing." As would be fairly inferred from Mr. Chauncey Depew's remarks, quoted in the review referred to, the latter class of employees has felt the effects of the hard times much more severely than the former; yet a great many men in the lower grades in departments of administration and transportation have been "laid off," and have been practically idle for many months. Exact figures showing the number of men laid off in all grades are not supplied, but, bearing in mind that those employed in reconstruction and repair are the principal sufferers, some inferences can be made from a personal letter quoted in the article under review, and written by Mr. F. W. Arnold, secretary of the Brotherhood of Locomotive Engineers.

In this letter Mr. Arnold estimates that at least 3000 locomotive engineers, 5000 brakemen, 2000 conductors, and 1500 telegraphers, all belonging to railroad organizations, have been thrown out of work. He will not even attempt to estimate the number of those laid off who do not belong to those organizations. It is doubtless very large. The business of railroading has received a set-back that will long affect dividends, but there is a limit to such economy as the roads have been practising, and the time approaches when they will be forced into the employment of more men. Doubtless some of the roads have already approached this limit so nearly that it has become necessary to consider the lines on which they will first increase expenditure. This will be done cautiously at first, but with increasing business and good crops full resumption on the old basis cannot be delayed long.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Industrial Sociology in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*30832. Malignant Effects of the Free Silver Delusion. Edward Atkinson (Eng Mag–June.) 3000 w.

†30945. The Free Trade Friction. A. Ewbank (*Ind Engng*–March 9.) 2400 w.

†30987. The Historical Aspect of the Monetary Question. Alexander Del Mar (*Fort Rev*–April.) 3500 w.

†30988. The China Problem and Its Solution. E. T. C. Werner (*Fort Rev*–April.) 6400 w.

*31011. Is Bimetallism a Fad? (*Bank Mag of Aust*–March.) 1500 w.

*31032. Report of the Royal Commission on the Aged Poor (*Jour Gas Lgt*–April 9.) 2000 w.

*31108. Belgian Trades Unionism as Viewed in the Light of French Experience. J. Lecocq (*Col Guard*–April 11.) 7000 w.

31199. The Silver Problem. Green Majors (Min & Sci Pr–April 20.) 1600 w.

*31269. Peace in China and British Trade (*Trans*–April 19.) 1500 w.

†31274. Our Situation Viewed from Without. Goldwin Smith (N Amer Rev–May.) 5800 w.

†31276 The Income Tax. I. The Decision of the Supreme Court. George S. Boutwell. II. The Spirit of the Tax. Plain Speaker (N Amer Rev–May.) 8000 w.

†31304. Business, Friendship, and Charity. Logan G. McPherson (Pop Sci M–May.) 6200 w.

*31306. The Social Pressure in Politics. William B. Chisholm (Am Mag of Civ–May.) 2900 w.

*31307. Civilization and the State. A. A. Johnson (Am Mag of Civ–May.) 5500 w.

*31310. American Trade Prospects in East Africa. Charles J. Zingg (Am Mag of Civ–May.) 1500 w.

*31313. Farmers and Taxation. James Middleton (Am Mag of Civ–May.) 4000 w.

*31315. Should Church Property Be Taxed? William H. Laird (Am Mag of Civ–May.) 1400 w.

*31345. The Petroleum Panic. Editorial (*Irm*–April 20.) 1500 w.

31379. The Oil Situation. Editorial (Pro Age–May 1.) 800 w.

*31398. Evidence of the Control of Industries by Workmen Shareholders (*Jour Gas Lgt*–April 23.) 2400 w.

*31405. The Present Condition of Russian Industries (*Bd of Tr Jour*–April.) 700 w.

*31409. Tariff Changes and Customs Regulations.—Russia, Norway, Sweden, Switzerland, France, Belgium, Spain, Portugal, Italy, Cyprus, United States, Mexico, Ecuador, Peru (*Bd of Tr Jour*–April.) 8000 w.

*31512. Trade Possibilities in China (*Eng*–April 26.) 1500 w.

*31528. The Argentine Republic.—Railways and Harbors (*Trans*–April 26.) 2000 w.

†31573. The State and Dwellings of the Poor. Frank Buffington Vrooman (Arena–May.) 7000 w.

†31597. Coin's Financial School Answered (Bank Mag–May.) 12000 w.

†31598. A Lesson from England's Banking Legislation. Winthrop M. Daniels (Bank Mag–May.) 4000 w.

Serials.

30453. Bimetallism vs. the Single Standard. L. Bradford Prince (Am Mag of Civ–Began April—2 parts to date—30 cts. each).

MARINE ENGINEERING

Steam Pipes.

THE numerous failures of steam pipes on shipboard are calling the attention of engineers to the underlying defects of these pipes and the necessity of finding a remedy. It is true that the large majority of failures are of minor importance and can readily be repaired; nevertheless, they give trouble, and add to the ever-increasing burdens of marine engineers. Some break-downs of steam pipes are however, so serious as to endanger life, and even to hazard the destruction of the vessels on which they occur. A failure of a steam pipe may temporarily cripple a ship as much as the breakage of a propeller shaft.

In a paper read before the Institution of Naval Architects by Mr. J. F. Milton and printed in *Engineering* (April 5) he directs attention to a growing disfavor on the part of marine engineers toward copper as a material for steam pipes. He gives a list of eight ships in which cast-iron replaced copper for this purpose, and in which the cast-iron pipes were subjected to a service of from 7 to 25 years, the average term of service for the ships named having been over 18 years. He thinks the selection of copper for marine steam pipes in the early days of marine engineering was influenced by its ductility and freedom from corrosion under the action of steam.

"It must be remembered that the advance of engineering of late has not only increased the steam pressure used,—and, therefore, the temperature also,—but engines are, in general, of much greater size and power than those used years ago. The steam pipes now, therefore, are, as a rule, larger in diameter, much thicker, and are subject to greater changes of temperature and expansion, &c., than formerly. These all make the pipes so much stiffer, or more rigid, that with many pipes, even when made of copper, their rigidity is so great that their yielding or altering form cannot be relied upon to relieve expansion strains, which have, therefore, to be provided for in the same way as they would need to be if the pipes were made of cast-iron." Seamless copper pipes are now made for steam purposes, and have met with some success. But trouble has also been experienced with seamless pipes.

Speaking of tests of pipes made by the Elmore process, and also of seamless drawn pipes, it is said that these tests were made with unannealed pipes. The pipes in this condition might show a high character for strength, but "this is a condition in which they could not be used for steam-pipes on ship-board. After annealing, the behavior of these pipes is not much different from that of ordinary copper pipes of equal thickness. Copper pipes are now frequently reinforced by iron bands at short intervals or by wrappings of wire or wire rope. Of the three remaining materials out of which steam-pipes can be made—cast-iron, wrought iron, and steel—Mr. Milton favors wrought iron. Whatever material is used, the importance of provision for expansion and drainage of the pipes must not be overlooked.

"Concurrently with the trouble of providing for expansion, &c., with thick and large pipes, there arises also a difficulty in manufacturing them. The usual method of making pipes of large diameter is to make them, both bends and straights, from copper sheets, the straights, except in very large pipes, having one seam along the entire length, the bends having two seams along the sides, the saddle and back pieces being each worked up from one sheet. The seams are invariably brazed, the edges of the copper being thinned down to form a scarf. Now, the difficulty of satisfactorily brazing a joint of this description increases rapidly with the thickness. The heat has necessarily to be applied from the outside, and has to pass through the thickness of the metal to reach the brazing solder, and thus the risk of overheating the copper on the outside, and consequently burning it, is much greater with thick than with fairly thin copper. There is also a further danger of deoxidizing the copper, both in the brazing and also in the previous annealings to which the copper has to be subjected. Amongst some of the earliest of those made some serious longitudinal defects (probably arising from a local defect in the original ingot being drawn out lengthwise in the manufacture of the pipe) caused them to be looked upon with a certain amount of suspicion, besides which the great difficulty of making satisfactory bends with these large pipes has no doubt had some influence in preventing their more general use. Regarding provision for expansion of pipes, whether of copper, iron, or steel, a point sometimes lost sight of is that it is not sufficient to provide a faucet joint in a straight length of pipe, but provision must also be made to anchor the ends of the length of pipe for the expansion for which provision has to be made, and so compel the movement of expansion to take place in the part provided for it; otherwise the end pressure on the pipes, amounting to several tons in all but the smallest pipes, will cause the joint to slide in the wrong direction. This has occasionally been overlooked in pipe designs. It is always difficult to provide for the expansion of large bends without producing excessive strains, so that, as far as possible, pipes should be made straight." The welding of flanges to sections of piping is preferred to screwing the flanges on the pipes.

Induced Draft Versus Forced Draft for Marine Boilers.

By "induced draft" is meant a draft produced by exhaust, as distinguished from one caused by increased pressure in the stokehold. Both result in increasing the difference between the atmospheric pressure in the furnace and that in the stokehold, and at first thought one might suppose the effect for a given difference of pressure ought to be the same, no matter how produced. But such a conclusion is not warranted by facts. The system of induced draft is now attracting much attention, and by some, among whom is M. W. A. Martin (*Industries and Iron*, April 5), it is regarded as superior to forced draft. The article referred to is an abstract of a paper read before the Institution of Naval Architects (April 13).

"The locomotive type of boilers has been largely adopted for marine purposes, but the system of working this kind of boiler has been reversed with very unfavorable results." The author, having made a large number of experiments in steam generation with all classes of boilers, was enabled to place before the meeting some particulars. "Although it has been sometimes maintained that, so long as you create a difference in pressure between the air in the chimney and that in the stokehold, it matters not whether you exhaust from, or blow to, the fire, yet it will be seen, upon closer examination, that the characteristics of forcing and inducing are widely different. The forcing system is advantageously used for blasting down ores, and for iron foundry purposes, where the metal can fall below the blast as soon as melted; but it is an unsuitable process for puddling, reverberatory, and reheating furnaces, such as are used in iron and armor-plate making, where volume and steady heat are required. For these purposes exhaust or induced draft is used.

"The marine boiler exposes a large mount of surface to be acted upon, and it is of primary importance that the heat should be evenly distributed over it, and not concentrated on particular parts. To effect this, the draught must have perfect control over the gases generated in the furnaces, as on the proper application of the draught the whole working of the furnaces depends. It is a tendency of the forced draft system, as used in the navy, to concentrate and localize the heat." There is thus seen to be an effect of distribution of the air in the furnace from induced draft, unattainable by the system of forcing. Mr. Martin gives tabulated results of a series of trials to test experimentally the truth of these propositions, made by him under permission of the admiralty, on H. M. S. Gossamer. A series of trials had been previously performed on H. M. S. Polyphemus, and the Gossamer experiments were arranged to test more crucially the results obtained on the Polyphemus. A series of experiments had before been carried out with forced draft on the Gossamer, and on both the vessels forced draft was experimentally contrasted with induced draft, with careful record of the results. On the Gossamer "there are two boiler rooms identically similar, and two boilers of the locomotive type in each. The forward boilers were selected for the application of the induced draft system, which was fitted in the uptake forward, leaving the stokehold in its original condition, with the air locks and other forced draft fittings unnecessary for induced draft. The air locks and hatches, however, were left open during the trials, and only in this respect was there any difference in the working of the two systems."

Not only was the power produced on this ship by induced draft, as shown in the tabulated statements, far in excess of that produced by forced draft, but a superior economy of fuel also resulted. A curious effect noted was that, when urging the boilers toward their highest capacity with forced draft, they primed very seriously, whereas they could be urged to a much higher evaporative capacity by induced draft, giving dry steam all the time. Injury to the boiler is less liable to occur with induced draft. Mr. Martin's theory regarding this comparative immunity is that the partial vacuum produced protects the ends of tubes, etc. The dryness of the steam, when an induced draft was used, is accounted for by the greater uniformity of temperature throughout the boiler. "Another important point in favor of induced draft is the saving of weight in comparison with forced draft. The iron work involved by the latter for casing and air locks in a first-class battleship is about 19 tons. This is dispensed with by the induced-draft system. The economy of fuel effected also tells in connection with weight."

Another important point is that "the principle of induced draft renders it quite independent of the length of the funnel. In fact, the funnel may be dispensed with altogether, so that, in the case of a war-vessel, if the funnel were shot away in action, it would not in any way affect the facility of steaming."

"It is remarkable that, while the forced-air system results in diminishing economy as the blast is raised, and there is a maximum pressure beyond which it is difficult to work at all, the induced system, on the contrary, gives an increased draft with no limit but the convenience of obtaining high speed of fan. The gases, being drawn through the tubes instead of being forced, are more perfectly consumed, and there is no lodgment of ashes in the tubes. So regular is the process of combustion that the quantity of coal consumed does not increase in anything like the same ratio with an augmented rate of working."

The Launch of the St. Paul.

THIS splendid ship has been successfully floated from William Cramp & Son's shipyard. She is the mate of the St. Louis, also built in the same yard. The completion and putting into commission of these great ships is an event in marine engineering too important and significant to be passed without general comment in all publications devoted to naval construction throughout the world. The following dimensions of the vessel given below are taken from *Seaboard* (April 11), which also publishes an engraving of the ship as she appeared on the stocks before launching.

The engines of this ship are the most powerful quadruple expansion engines ever built, and this fact alone is sufficient to arouse the interest of marine constructors, as it will test the principle of quadruple expansion on a scale never before attempted. "Steam is to be supplied by six double-ended boilers, each 20 ft. long by 15 ft. 7½ in. in diameter, with 39 furnaces, making a total grate surface of 830 sq. ft. and a heating surface of about 30,000 sq. ft. In addition to the main engines, there are forty-nine auxiliary engines in each ship, being used for all kinds of purposes."

The outfit of the ship will be as complete and elegant as money can purchase. A number of the state-rooms are suites of three apartments, consisting of a parlor, bedroom, and bathroom. The steerage furnishes accommodation for 900 passengers. The profusion of lavatories and bathrooms is a feature of the design which will be highly appreciated by passengers. Four powerful dynamos will supply current for electric lighting, which will be wholly incandescent. A system of forced ventilation supplies pure air to all parts of the ship. Provision is made for warming the air thus supplied in cold weather, and also for individual control of ventilation by occupants of state-rooms. The state-rooms are furnished with side-lights and automatic valves that exclude water.

This vessel accommodates eighteen hundred people,—passengers and crew. She could transport the population of many an American village with all its moveable effects in a single passage. "To insure the safety of this great number while on the sea every device of known value has been applied. The bulkhead divisions have been so constructed that with any two, or even three, compartments flooded the vessel would remain perfectly seaworthy. Complete boat accommodations will also be provided for every one on board. Another great advantage in these American liners is that they are fitted with two sets of engines, each driving a separate screw. The engines are in two separate compartments divided by a water-tight bulkhead, and the boilers are in separate compartments completely cut off from each other, so that the vessels might come into collision by being struck on the bulkhead, and could have a break-down in their machinery, such as may occur in any ordinary ship, and still be navigable and thoroughly safe and seaworthy. In order to avoid waiting for high tide for several hours outside the harbor bar, either at New York or on the other side, the St. Louis and St. Paul have been designed for light draught. Proper immersion for the screws will be obtained by the use of water ballast, and before reaching the bar this water ballast will be pumped out and the vessel's draught greatly lessened. This is also a double precaution against injury by grounding." The dimensions of the St. Paul are: "Length between perpendiculars, 535 ft.; length over all, 554 ft. 2 in.; extreme beam, 62 ft. 9 in.; depth from first deck to flat keel, 42 ft. 4 in.; depth of hold for tonnage amidship, 23 ft. 2 in.; height of bow above water line, at load draught, 39 ft.; number of decks, 5; number of water-tight compartments, exclusive of ballast tanks, 12; gross register, 10,700 tons; load displacement, 15,600 tons; dimensions of main saloon, 109 ft. 4 in. by 46 ft.; dimensions of second cabin, 39 ft. 6 in. by 56 ft.; seating capacity of main saloon, 322; seating capacity of second saloon, 208; berthing capacity of steerage, about 900."

The Quickest Voyage from China to New York.

THE recent trip of the bark Amy Turner from Hong Kong to Chesapeake Bay in 88 days recalls to Captain J. M. Cavarly, in *Seaboard* (April 4), a still more remarkable trip made by Captain Robert H. Waterman in the ship Natchez in 1845, wherein the trip from Hong Kong to New York was made in 78 days and 6 hours. In 1846 the same captain made the trip in the clipper ship Sea Witch in 82 days "against the strength of the south-west monsoon." In 1847, "in the same vessel, with a fair monsoon, he made the trip inside of 76 days,—probably the shortest time ever made by a sailing vessel between the two ports." The entire distance sailed is close to 14,000 miles. The average daily distance run is, therefore, something more than 186 miles. The article is illustrated with a portrait of Captain Waterman, and an abstract of the voyage in the Natchez in 1845, compiled from the log-book, is appended.

Controlling Valve for Steering Engines.

THE steering engine is a noisy device when the work it does is considered, and it has extremely low efficiency as a motor. *The Marine Engineer* May 1, in describing a new controlling valve for steering engines, explains the small efficiency by the fact that at mid-position of the rudder,—the position of least load,—just as much steam is inducted as at extreme helm positions when the load is greatest. The engine is, therefore, for the greater part of the time exhausting high-pressure steam. The new controlling valve appears calculated to lessen both the noise of the machine and the waste also.

A valve arranged over a double-ported seating, is fitted on the slide case of the engine just above the ordinary controlling valve. This valve is automatically operated in conjunction with the travel of the tiller, in such a way that more steam is admitted to the engine as the helm goes over and the load increases, while, when the helm is at or near the mid-position, very little steam is admitted to the engine, only just such a quantity being allowed to pass as will drive the engine at a sufficient speed for efficient steering. The valve is operated by a bell crank lever, one arm of which is connected to a nut, worked by the helm indicator, It is claimed that this device can be fitted to existing machines. Its advantages seem undeniable.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Marine Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

30862. The St. Paul Launched. Ill. (Sea April 11.) 2800 w.

30867. Experiments in Navigation With a Compressed Gas Motor. Ill. From La Nature (Sci Amer Sup–April 13.) 1800 w.

30882. The Jurisdiction of the Secretary of War Over Navigable Waters. Editorial (Eng News–April 11.) 2200 w.

*30916. Remarks on Steam Pipes. J. T. Milton (*Engng*–April 5.) 4000 w.

*30928. Induced Draught for Developing the Power of Marine Boilers. W. A. Martin (*Ind & Ir*–April 5.) 1200 w.

30977. School for German Marine Engineers and Machinists. From Consular Reports (Eng–April 13.) 1000 w.

31016. Sickels' Steam Steering Gear on the "Pensacola." I. McKim Chase (Am Mach–April 18.) 1000 w.

31026. How to Equalize Protection and Promote Shipbuilding. Editorial (Sc A–April 18.) 1600 w.

31027. The Launching of the New American Steamer St. Paul. Ill. (Sci Amer–April 20.) 600 w.

*31098. The Elements of Force in a Warship. Review and Discussion of Paper by P. H. Colomb (*Engng*–April 12.) 5000 w.

*31099. Discussion of Paper by J. T. Milton, on "Remarks on Steam Pipes" (*Engng*–April 12.) 4200 w.

*31100. Review and Discussion of Paper by George Rickard on "Light Draught River Steamers" (*Engng*–April 12.) 2800 w.

*31101. An Aluminum Torpedo Boat. Ill. A. F. Yarrow (*Engng*–April 12.) 2000 w.

*31103. On Solid Stream Forms, and the Depth of Water Necessary to Avoid Abnormal Resistance to Ships. D. W. Taylor (*Engng*–April 12.) 3000 w.

*31114. Engine Room Practice at Sea. W. M. Binny (*Marine Eng*–April.) 2800 w.

*31132. Water Supply on Board Ship (*Trans*–April 12.) 1000 w.

31170. Ocean Tramps (Mnfr & Builder–Dec.) 1200 w.

31190. Triple Screws (Sci Amer–April 27.) 900 w.

31193. The Magnetic Needle. Vaughan Cornish (Sci Amer Sup–April 27.) 1900 w.

31232. A Fast Lake Steamer of 1860.—The City of Buffalo (Eng–April 27.) 700 w.

*31270. The Water-Tube Boiler Question (*Trans*–April 19) 3500 w.

*31294. On the Vibrations of Ships and Engines. Ill. A. Mallock, with Discussion (*Engng*–April 19.) 10000 w.

31297. The Waste and Supply of Shipping. Editorial (*Engng*–April 19.) 1800 w.

*31300. On Vibrations of Higher Order in Steamers, and on Torsional Vibrations. Otto Schlick (*Engng*–April 19.) 3200 w.

*31333. On a Method of Preventing Vibrations in Marine Engines. Mark Robinson and H. Riall Sankey (*Eng*–April 19.) 3500 w.

*31335. The Vibrations of Steamships and Engines. Editorial (*Eng*–April 19.) 1200 w.

*31346. Engineers in the Navy. Editorial (*Prac Eng*–April 19.) 2000 w.

31386. The Lighthouse Supply Steamer, Armeria. Ill. (Sc A–May 2) 900 w.

31390. The Battle Ships Magnificent and Charlemagne—A Comparison. Ill. (Sci Amer Sup–May 4) 650 w.

Serials.

16636. Marine Engine Design. Ill. (*Mech Wrld*–Began Oct. 6, 1893—23 parts to date—30 cts. each).

30466. Protection to Agriculture and Shipping—The Lubin Proposition Considered by Our Shipbuilders (Sc A–Began March 28—2 parts to date—15 cts. each).

30482. Large Ships of Cellular Type. Ill. William Bell (Am Ship–Began March 28—Ended April 18—3 parts—15 cts. each).

30576. Turret-Deck Cargo Steamers. S. O. Kendall (*Ind & Ir*–Began March 22—4 parts to date—30 cts. each).

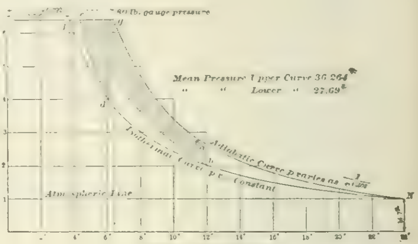
We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Compressed Air.

Of the compression of air by power-driven compressors, Mr. W. H. Booth makes some sensible remarks in *American Machinist* (April 18). As to compression of air with and without cooling, he thinks that, if any one goes into a study of these methods, "he will come out of it with the conviction that air-compression is an operation that requires time, owing to the difficulty of cooling the air with rapidity during compression." "Overlooking for the moment the mechanical advantages of air-compressors built on the direct-acting principle, it would appear that direct action is not a consistent practice, for slow movement is bad for the economy of the steam cylinder, and good for the air cylinder, and some indirect connection which should allow the steam piston to travel much faster than the air piston is clearly indicated by the physical conditions of the problem."

We have reproduced a diagram used by Mr. Booth in illustrating the effect of stage compression with intermediate cooling. In it are drawn "two curves marked respectively 'isothermal' and 'adiabatic,' the first being the pressure curve resulting from the compression of air from atmospheric pressure to 80 lbs. gage pressure at so slow a rate of speed as will allow the air to become cooled as quickly as it is compressed, the second being the curve due to the compression of the air, the temperature increasing as it is compressed, and losing no heat by radiation or cylinder conduction. Of course these curves are both impossible in practice. They are the extremes between which every compression curve will lie. Let us now suppose that the piston is at the end of its stroke, and moves suddenly to the middle of the cylinder; and the adiabatic curve is followed to *a*. There the piston waits while the air cools, and the pressure falls to *b* on the isothermal curve. Thence the piston moves forward half the remainder of the stroke, and the curve *b c* is traced by the indicator pencil; the piston again waits until the temperature falls, and the pencil drops to *d* on the isothermal. Completing its stroke, the piston forces the air again to give the curve *d e*. The diagram is thus made up of the three short curves, *n a*, *b c*, *d e*, joined by the vertical lines of cooling *a b*, *c d*.



Air Compression

"Though inclosing a larger area than the isothermal curve, yet the treble curve area is very much smaller than the area inclosed by the adiabatic diagram, and the difference is all so much power economy. Though this system of piston movement and stoppage is not a practicable system, it points to a system which is practicable, and which is productive of economy wherever its principles are followed out. I refer, of course, to the compound system, which seems to be eminently suited to the process of air-compression. In place of the three-step diagram of the illustration, there would be three cylinders in series, each forcing air to an intermediate receiver exposed to external cooling influences. In passing through such receivers the air would be deprived of the additional temperature it has acquired by each step in the series of compression, and though, of course, there is no added complication of extra cylinders, these can be all placed tandem fashion on one rod, and the same mechanical advantages are secured as in the compound steam engine, such as reduced stresses on the crank pins or rods, reduced periphery of leakage on the highest pressed piston, etc., all which, with the saving of power, make compound air-compression fully as reasonable as compound steam-expansion."

As to the curves called "pressure curves" by Mr. Booth, it may be added that they are both pressure and temperature curves. In drawing these curves the abcissas represent volumes, and are mathematical functions of both pressure and temperature. Of cooling air in the cylinder during compression no quick and perfect way has yet been devised. Injection of water in the form of spray has not been abandoned, as Mr. Booth thinks, on account of its saturating the air with moisture. It is rare, even without the use of this method, that ordinary air contains enough water to saturate it after compression to 3 atmospheres and cool it again to its original temperature. There are other practical objections to the use of water in air-compressors. It is not always practicable to obtain a supply of water sufficiently free from abrasive particles, and appliances for spraying the water into the cylinder and separating and trapping it out afterward add considerably to complications and cost. Stage compression, with intermediate cooling in surface coolers, is the most rational way, and only in the first cost of apparatus is it any more expensive. The better results more than compensate for increase of first cost in any case where the amount of work is moderately large.

"The diagram corresponds with a cylinder of 24-in. stroke. The space occupied by the heated compressed air is seen to be 6.392 in. of the length of the cylinder, —that is to say, when the piston arrives within this distance of the end of its stroke, the air will raise the valve leading to the reservoir, which is supposed to carry 80 lbs. gage pressure. If, however, the air could be cooled as fast as it is compressed, the space occupied would only be 3.725 in. In the first place the piston must move against the reservoir pressure 2.667 in. more than in the second case. The mean pressures are, respectively, 36.264 lbs. and 27.69 lbs.,—a ratio of 100 to 131 very nearly.

"If, now, the cooled air were allowed to expand again from the point *f*, without receiving heat, the curve of the diagram would, being adiabatic, fall below the isothermal curve of the illustration. Hence it is obvious that in compressing air, if we compress along the curve *Ng* and expand again along the curve *f N*, the air having cooled from *g* to *f* in the pipes, we shall lose enormously. We have, therefore, to endeavor as far as possible to compress from *N* to *f*, then add heat, and expand from *g* to where? Not to *N*, if we can help it, because this means that we have only heated the air and not the cylinder; we must try to expand down a curve which rises above *N* by continuing to add heat to the cylinder, just as we add heat to a steam cylinder by means of a jacket. By so doing we can cut off earlier on the working stroke," and this means economy, precisely as an early cut-off with high pressures means economy in steam engines.

Hydraulic Air Compression.

A SYSTEM (said to have been patented) for the hydraulic compression of air is described and illustrated in *The Canadian Engineer* for April. The system is based upon a long-known and anciently-used principle, and the apparatus, as described, is nothing more or less than a trompe,—an apparatus which came into use in the south of France about 200 years ago for blowing forge-fires, and which at one time was widely employed for this purpose. There are, however, some details in the new apparatus upon which a patent could have been obtained; and perhaps in the application of the air compressed in this way as motive power for tram-cars there may have been some patentable features. If this be true, the article under review does not intimate what they are. It asserts, however, that the system as a whole is "fully covered by patents and is controlled by a joint-stock company." As to the probability that any very broad patent claims upon this alleged invention could be sustained, should the patent ever be subjected to litigation, those familiar with the trompe will be able to form an opinion after perusing the description which follows.

"Briefly stated, the air is compressed by the direct action of falling water without the aid of any moving machinery, and practically without expense for maintenance or attendance after installation. By this system any fall of water varying in working-head may be utilized, and any pressure required can be produced and uniformly maintained up to the capacity of the water power, delivering the compressed air at the temperature of the water, and in a drier state than is possible by any known means of compression, thereby avoiding all loss by condensation or shrinkage by cooling of the air after compression. The water may be conveyed to the compressor by means of an open flue, or through a pipe supplying a tank or stand pipe round the head-piece of the compressor, where it can attain the same level as the water in the dam or source of supply. Around the head-piece are placed a large number of small horizontal air-pipes, drawing their supply of air through larger vertical pipes, which extend above the surface of the water and open to the atmosphere. As the water enters the down-flow pipes, it draws in the air in the form of small uniform globules, which, becoming entangled in the descending water, are carried down to the receiver at the bottom of the pipe, compressing the air by the pressure of the water surrounding these globules until they reach the point of separation. This pressure is maintained so long as there remains any air in the receiver."

These small induction air-pipes appear to be a new feature, and they doubtless add much to the efficiency of the apparatus. "The receiver is sufficiently large in diameter to allow the air to rise to the surface of the water therein, from whence it is taken through the air-pipe for transmission to be utilized as power or for other purposes. The water, being kept down by the pressure of the air, is forced out through the bottom of the receiver and up the shaft around the down-flow pipe to the tail race level." There are also some details of the receiver that doubtless aid in the operation of this improved trompe, for such it must be considered. Considerable stress is laid upon the fact that the compressed air contains less moisture than the air before compression. This fact, however, is incorrectly stated in the description, which says that the air in the receiver after the compression is *drier* than before. As a matter of fact, air compressed while in contact with water is always saturated (or very nearly so) with moisture after the compression, and is therefore wet air. It holds all the moisture it can hold at the temperature of the water with which it has been brought into contact, and if, while the pressure is maintained, the temperature be lowered, it will immediately precipitate some of this moisture. The fact remains that, nevertheless, it may contain less water than before compression. Dryness of air depends upon temperature and pressure, not alone upon upon the pressure. Hot air containing a given amount of water may be much drier than cold air containing less. Air taken from the receiver of this apparatus, and used in a motor without reheating, will as surely drop its moisture in exhaust ports as though it were compressed in an ordinary compressor with injection of water, and in this respect there is not the slightest advantage in the use of the trompe. It is rather surprising that, in the face of what is now so generally known about the behavior of compressed air in motors, such a claim should be publicly made. There are other claims that appear absurd, but let these pass. It appears to us extremely doubtful that a system long since obsolete can be thus revived by a few slender modifications, none of which appear to be essential to the application of the principle that entrained air can be carried down by a stream of water in a pipe, and separated under pressure in a receiver below. The manufacture of power-driven air-compressors is not likely to suffer from this scheme.

Raising Water by the Air-Lift.

It has long been known that a suction pump could be made to raise water considerably higher than the height of a solid column of water in a tube balanced by atmospheric pressure, by the simple device of allowing some air to leak into the suction pipe. This is explained by the fact that a column of mixed water and air vesicles is lighter per foot of height than water unmixed with air, and hence the atmospheric pressure upon the surface of the water wherein the suction pipe is placed can lift a higher column of the former than of the latter. It does not seem to have been known till recently that water or any other liquid could be raised effectively through an open vertical tube inserted in a mass of the liquid, by forcing air into the open end of the bottom of the tube, and that the farther below the liquid surface the lower open end of the tube is placed the greater and more powerful will be the discharge, provided the injection of air is proportioned rightly to the work to be performed.

The action, after the air enters the lower part of the tube, is simply due to gravity. The mixed air and water is lighter than the solid water, and is therefore pressed upward by the weight of denser water outside of the tube, precisely as though it were a cylinder of cork. This system of raising water, which has latterly come into extensive use, and which is known as the Pohle air-lift (named after the inventor), has proved to be one of the most important of modern innovations in the field of hydraulic engineering. *The Engineering Record* (April 20) has commenced a series of articles upon the subject, the first giving an account of the circumstances that led up to the invention and naming a considerable list of installments where the invention has been advantageously applied. The article asks for explanations of the action of this pump from hydraulic engineers, and doubtless there will be more than one theory advanced. This action seems, however, not at all mysterious to us.

If a series of cork plugs could be successively placed in the bottom of a tube inserted in a mass of liquid, and could freely move upward, dividing the column within the tube into alternate strata of water and cork, the action would be exactly the same as when the air plugs are inserted, and the work of the lift (disregarding all losses between the prime motor and the bottom of the tube) would be exactly what is required to force the continuous rank of corks down from the surface to the point of entrance. The system seems to be a very economical and effective way of applying power for raising water, but there is nothing occult in the principle of its action.

Of course it follows theoretically that the deeper the lower end of the tube is submerged, the higher the mixed column of water and air can be raised above the surface. In practice, however, there are limitations to the application of the theory. It is not advised to exceed 150 ft. at a single lift; but, by delivering the lifted water into stand pipes at successive elevations and supplying each with an air-lift, water may be raised from any level to any other accessible level. If the original source of supply be a shallow stream, not admitting of deep submergence, the initial lift will be short, but by increasing the depth of the successive stand pipes at diferent elevations deeper submergence and higher lifts may be obtained, till the practicable limit of a single lift is reached. One of the most important points in connection with this system is the reason (or reasons) for the practical limitation of the lift, since theoretically, with an unlimited submergence of the lower end of the tube, there would seem to be no assignable limit to the lift. The system may easily be exemplified experimentally by any one. A piece of straight glass tubing of from ⅜″ to ½″ calibre, a smaller blowing-tube, one end of which is bent so that it can be put up into the bottom of the straight tube, and a water-pail are all the apparatus needed. Place the straight tube down in the water, pass the bent end of the blowing-tube down into the water and up into the open end of the straight tube, blow into the upper end of the blowing-tube, and mixed water and air will be lifted in the straight tube.

Centrifugal Pumping from Pits.

THE use of centrifugal pumps in California valleys in raising water for irrigation, having led to frequent inquiries as to the details of the system employed, Mr. Byron Jackson, of San Francisco, in *Industry* for April, supplies the desired information by an illustrated description, of which, in this review, we can give only an outline.

First pits about 12×6 ft. are sunk from 40 to 80 ft. below the surface and lined with 2×12 in. red-wood planks, "half notched at the corners so as to require no framing." A temporary pumping-plant is used to keep the pits free from water during the processes of sinking them below the standing level of the water in dry weather. Then artesian wells are bored from the bottoms of the pits to depths of from 50 to 200 ft., and lined with riveted pipes.

The centrifugal pumps are mounted on platforms at the bottoms of the pits ; or, in some cases, "the platform is suspended so that it can be raised or lowered," as the level of the water in the pits rises or falls. The suction pipes feed into the tops of the pumps, which are driven by vertical shafts taking power from an engine by belt. "The suction pipes enter on top of the pump, as shown in the drawing, and extend down into the tube wells 35 ft. or more, so that the water cannot fall below the intake end. If the supply is less than the pumping rate, no air can enter, and the charge of water does not run back.

"The water is taken in at the top of the pump for several purposes. It permits the well-pipes to be withdrawn vertically, and enables the pump-shafts to be sustained by the action of the water. The weight of the pump-impeller and driving shaft—sometimes a ton—are balanced by the water-thrust, and the shafts therefore run in equilibrium. The proportions, deduced mainly by experience, are unusual. The up-take pipe has usually four times the area of the pump-discharge nozzle, and the aggregated area of suction pipes is larger still, so that the flow is reduced to 3 or 4 ft. a second. For a head of 100 ft. the velocity of the impellers is about 90 ft. per second at the periphery, and the revolutions from five hundred to eight hundred per minute, according to the diameter of the impeller. Formerly these pumps were made compound, so as to run at a lower velocity, but the simple form now prevails even for heads exceeding 100 ft. The supply raised for orchards is from 600 to 150 gallons per minute, which forms quite a stream, and as much as can be managed by a distributing force of men who direct the water over the ground."

The pumps are charged by injectors. Ascent and descent to and from pumps is accomplished by vertical ladders. "The water, as it issues from the main pipe, is a beautiful sight,—as clear as crystal, and often charged with gas, so as to present a silvery appearance ; but it commonly carries in suspension a good deal of fine gravel that can be heard impinging against the sides of the pipes by applying one's ea to the outside. A person not experienced in the matter does not realize what 150 gallons a minute means. It is a small river, and seems out of all proportion t the diminutive little machine that impels it. The efficiency attained in these plants is from 40 to 60 per cent., which is far i excess of what would be inferred ; but the fact is that the machinery is commonly o a high class, with no makeshift appliances anywhere. Cords of wood and inches o water are pretty well understood among the orchardists and valley farmers, wh are usually a well-educated class of people often well versed in hydraulics and motive power." Mr. Jackson states that no other kinds of pumps will answer for this work The fine gravel which is brought up by the water would in a short time destroy an form of piston or plunger pump. The firs cost of a centrifugal pump is only abou half as much as that of a piston-pump o from one-eighth to one-sixth the same delivery. The "relative investment is a twelve to one, considering the pump alone and for the whole plant together there i a saving of at least one-third." Moreover "there is no type of piston pump tha would not fill up the pits and prevent access to the wells." The method is explained to be the outcome of 20 years' experimental evolution, and to be in ever way satisfactory.

The Sickels-Corliss Controversy.

As regards the merits of this controversy, we think that, after perusal of a article by Mr. W. F. Durfee in *America*

Machinist (April 11), any unprejudiced mind capable of weighing evidence will come to the conclusion that Frederick E. Sickels conceived the first practicable apparatus for lifting, tripping, and regulating the closing of the valves of steam engines; and George H. Corliss, notwithstanding the allegations that he got the idea of his inventions from the study of Sickels's cut-off device, used nothing that Sickels had secured by patent, while his cut-off was a real and marked advance on Sickels's invention.

The possibility of such a movement had been seen by others, and unsuccessful attempts at doing the same thing had been made. It appears that Sickels claimed less in his application than he was entitled to, and that he failed to discover this weakness till the litigation between the two men was commenced. The attempt of either party to prove that the other had not invented the thing he patented failed, and the patents of both stood unimpaired by any evidence brought against them.

Judge Grier evidently so regarded the matter when, in his decision, he said: "Corliss has invented an improved method of opening and shutting circular slides, or sliding valves; has shown another combination of devices for tripping the valve, and how his falling weight, used to close the valve, may be cushioned without jar on an air cushion. One has perfected one combination of devices for tripping a puppet-valve; the other a different one for a different valve. One has discovered and perfected a water reservoir to prevent the destruction of his valves when falling into place; the other has converted his falling weight into a piston working into a socket and cushioned on air so as to break the shock of its fall. They have each perfected a different machine by appropriate devices so as to operate beneficially, and I cannot perceive that the combination of elements in each is the same, and that their difference is merely colorable and not substantial."

If Judge Grier was right in this view,—and from the evidence we think he was right,—the litigation ought to have ended the controversy, and its revival after the death of both contestants can do no good except, perhaps, to insure that the honor of priority in the invention of a trip cut-off device for steam-engine valves shall be accorded to Sickels. The fact that Sickels's invention suggested a still better one to Corliss ought not to reflect any dishonor upon the latter. It is rare that the first practicable device for effecting any mechanical result is not ultimately superseded by something better, or at least equally good. That Corliss was a better business man than Sickels can hardly be counted against him, and for our part we are willing to believe that the wealth acquired by Mr. Corliss from his improvements was as honorably gained as any fortune similarly amassed in the history of patented improvements.

Both these men honored their country by their talents. Both have passed from the scene of human action. That one died rich, the other poor, matters nothing to either now. What benefit can the revival of this dispute render to any one? Let it and them rest in peace.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

The Machine Shop.

30850. Machine Molding With Special Reference to the Manufacture of Gears. Ill. S. Groves (Ir Age–April 11.) 3000 w.

31194. Fast Lathe Work. Ill. Isaac Chick (Am Mech–April 25.) 3000 w.

31243. Future Improvements in Foundry Work. Herbert M. Ramp, with Discussion (Ir Tr Rev–April 25.) 4000 w.

*31365. Boiler Making. C. E. Fourness (Loc Engng–May.) 900 w.

31417. New Tools for Turret Machine Work. Ill. (Am Mach–May 2.) 1000 w.

Steam Engineering.

30919. Initial Increase of Entropy, and Thermal Lag in Steam Machinery. Charles M. Jones (Am Mach–April 11.) 1500 w.

30976. Stationary Boiler Practice and Shop Heating. Notes of C. M. Higginson, with Discussion and Editorial. (Ry Rev–April 13.) 2200 w.

We supply copies of these articles. See introductory.

31014. The Hogan Vertical Water-Tube Boiler. Ill. (Ir Age–April 18.) 1500 w.

*31031. The Steam Engines (Persons in Charge) Bill (*Mech Wrld*–April 12.) 2400 w.

31093. The Woburn Explosion.—What the Inquest Discloses (Bos Jour of Com–April 20.) 3300 w.

*31112. Smoke: Its Production and Prevention. Vivian B. Lewes (*Gas Wrld*–April 13.) 4800 w.

*31121. The Governing of Steam Engines. G. L. Addenbrooke (*Elect'n*–April 12.) 1500 w.

31189. The Holly Gravity Return System for Utilizing Water of Condensation. Ill. (Elec Eng–April 24.) 1800 w.

31213. Causes of Explosions, Weight, Volume and Velocity of Steam, and Boiler Testing (Safety V–April 15.) 1800 w.

31216. The Making of Steam (Safety V–April 15.) 2000 w.

31230. The Woburn Explosion—Report of the State Inspector as to the Cause (Bos Jour Com–April 27.) 2800 w.

31231. Steam Pipes for High Pressures—Mild Steel Recommended by English Engineers (Bos Jour Com–April 27.) 1500 w.

31244. Hints on Boiler Inspection. Charles H. Garlick (Sta Eng–April.) 1200 w.

31247. Packing Rods. George West (Sta Eng–April.) 800 w.

*31280. The Conditions Necessary for Flame. W. H. Booth (*Elec Rev*–April 19.) 1000 w.

31469 Boiler Setting. Ill. George H. Barrus (Eng Rec–May 4.) 1800 w.

31470. The Ideal Cotton Mill Steam Plant. (Extract) George I. Rockwood (Eng Rec–May 4.) 1900 w.

31475. Hints on Boiler Inspection—How an Engineer Thinks a Boiler Should be Cared for (Bos Jour Com–May 4.) 900 w.

31501. Losses in the Steam Engine. William A. Bole (Am Gas Lgt Jour–May 6.) 4800 w.

*31535. The Care of Boilers. F. Riddell (Am Mill–May.) 1000 w.

31593. Some Historical Notes Relative to Governors and Their Use for Determining the Point of Cut-off in Steam Engines. Ill. W. F. Durfee (Am Mach–May 9.) 2000 w.

Miscellany.

*30833. The Growth of American Export Trade.—Words of Wisdom for Manufacturers. T. A. Eddy and Carl Schurz (Eng Mag–June.) 3000 w.

†30856. The Redheffer Perpetual Motion Machine. Ill. Henry Morton (Jour Fr Inst–April.) 1000 w.

30865. The Taylor Hydraulic Air Compressing System. Ill. (Can Eng–April.) 2300 w.

*30900. How the Moderns Move Heavy Masses Ill. (Stone–April.) 1300 w.

*30903. Steel vs. Iron Fire Box Stays. Editorial (*Eng*–April 5) 1400 w.

30918. Frederick E. Sickels and His Cut-off. W. F. Durfee (Am Mach–April 11.) 2500 w.

30920. Lubricators. Ill. (Inv Age–April.) 900 w.

*30941. Sand Blast Processes. Ill. John J. Holtzapffel (*Jour Soc of Arts*–April 5.) 8800 w.

30966. A Correct Method of Estimating the Torsional Strength of Shafting. C. R. Tompkins (Age of Steel–April 13.) 1200 w.

31017. A New Crank Pin Without Loss of Time. Charles A. Hague (Am Mach–April 18.) 1500 w.

31018. Machine Shop Discipline. W. D. Forbes (Am Mech–April 18.) 900 w.

31019. Fly-Wheel Arms. Ill. Albert E. Guy (Am Mach–April 18.) 2000 w.

31020. Compressed Air for Small Engines. Frank Richards (Am Mach–April 18.) 2000 w.

31021. Air Compression--A Bit of History. W. H. Booth (Am Mach–April 18.) 1600 w.

31028. How Brass Musical Instruments Are Made. Ill. Edward Salmon (Sci Amer Sup April 20.) 1800 w.

31050. Gas and Oil Engines and Their Prospects.—Discussion at the "Engineering Evening" of the Amer. Soc. of Mech. Eng. (Eng News–April 18.) 3500 w.

31171. The Relative Value of Different Fuels. E. P. Reichhelm (Mnfr & Builder–Dec.) 1200 w.

31172. The Potential Heat in Coal. W. E. Partridge (Mnfr & Builder–Dec.) 1500 w.

31182. American Tools in England. Interview with Charles H. Churchill (Ir Age–April 25.) 1700 w.

31195. Energy Equivalents. Edward J. Willis (Am Mach–April 25.) 1200 w.

31215. Energized by Inter-Atomic Ether.—The Keely Motor Ready for Work—So It Is Said (Safety V–April 15.) 1000 w.

†31305. Woman as an Inventor and Manufacturer. Ill. Otis Tufton Mason (Pop Sci M–May.) 3500 w.

*31348. The Meneely Tubular Bearing. Ill. (*Prac Eng*–April 19) 1200 w.

31354. Successful Management. C. R. Tompkins (Age of St–April 27.) 1400 w.

31387. Scientific Safe Making—Manufacture of Burglar Proof Safes (Sci Amer–May 4.) 900 w.

31394. The Fan Blower (Ir Age–May 2.) 1200 w.

31396. The Hill-Cimbing Bicycle. Oberlin Smith (Ir Age–May 2.) 2000 w.

*31411. Manufactures on the Pacific Coast (Ind'y–May.) 1500 w.

*31412. The Girard Water Wheel Company, San Francisco. Ill. (Ind'y–May.) 1000 w.

31418. Weight and Mass. Charles T. Porter (Am Mach–May 2.) 2500 w.

*31423. Some Experiments on the Efficiency of Air Propellers. Ill. Henry Goldmark (Am Eng & R R Jour–May.) 1800 w.

31424. Coal Handling by Machinery. Ill. (Power-May.) 1200 w.

31473. Water Power.—At Lowell. (Extract). Samuel Webber (Bos Jour Com-May 4.) 1300 w.

†31484. System in a Technical School Shop. W. H. Vandervoort (Tech-No. 9) 1800 w.

†31489. Tests of Three Babcock and Wilcox Boilers at the Champaign Electric Light and Power Station. R. A. Wood (Tech-No. 9.) 2500 w.

*31509. Apparatus for the Combustion of Small Coal. Ill. Felix Colomer (*Col Guard*-April 26.) 4000 w.

*31518. Rock Drilling Machinery. Editorial (*Min Jour*-April 27) 1400 w.

*31534. The Measurement of Power. F. Riddell (Am Mill-May.) 1000 w.

31581. Compressed Air: Its Utility and Advantages as Applied to Foundry Purposes. Howard A. Pedrick (Ir Age-May 9.) 3200 w.

31582. The Johnson Plant at Lorain. Ill. (Ir Age-May 9.) 5000 w.

31589. Force and Energy. Editorial (Sci Amer-May 11.) 900 w.

31590. Purdue University, La Fayette, Indiana. Ill. (Sci Amer-May 11.) 1200 w.

31596. Compressed Air vs. Electricity. Frank Richards (Am Mach-May 9.) 1600 w.

†31613. How Pneumatic Tires Are Made. John F. Grierson (Ind Rub Wld-May 10.) 1300 w.

Serials.

13033. Practical Hints to Boilermakers and Templaters. Ill. (*Mech Wrld*-Began May 12, 1893—17 parts to date—30 cts. each).

16781. Rope Driving. J. J. Flather (Elec Wld-Began Oct. 26, 1893—15 parts to date—15 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (*Elct'n*-Began Dec. 1, 1893—33 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (Eng Mech-Began Feb., 1894—13 parts to date—30 cts. each).

21141. High Speed Steam Engines. John Radinger (Eng Mech-Began April, 1894—14 parts to date—30 cts. each).

24338. The Gas Engine (Pro Age-Began Aug. 15, 1894—13 parts to date—15 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (*Elec*-Began Aug. 31, 1894—17 parts to date—30 cts. each).

27182. Notes on the Construction and Use of Pressure Gauges. C. R. L. Lemkes (*Mech Wrld*-Began Nov. 23, 1894—Ended April 26, 1895—5 parts—30 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (*Mech Wrld*-Began Dec. 7, 1894—8 parts to date—30 cts. each).

29630. The New Nordenfelt Guns. Ill. (*Engng*-Began Feb. 15—Ended April 12—8 parts—30 cts. each).

29777. The Deterioration of Locomotive and Marine Boilers Due to Expansion and the Means of Lessening the Same. Herr Lentz (Am Eng & Rail Jour-Began March—Ended May—3 parts—30 cts. each).

29886. Defects in Steam Boilers. Ill. From Report by the Austrian Asso. of Eng. & Arch. (Ir Age-Began March 7—3 parts to date—15 cts. each).

30098. Inventions in the Wool Manufacture. S. N. D. North (Inv Age-Began March—Ended April—3 parts—15 cts. each).

30118. Force, Energy and Power. P. Lobben (Am Mach-Began March 14—2 parts to date—15 cts. each).

30216. Care and Maintenance of Machinery. "Quirk." (Tradesman-Began March 15—4 parts to date—15 cts. each).

30285. Engine Frame and Cylinder Tools. Herman Landro (Am Mach-Began March 21—2 parts to date—15 cts. each).

30456. The Cornell Dividing Engine. Ill. George F. Ballou (Am Mach-Began March 28—2 parts to date—15 cts. each).

30555. The Proportions and Movement of Slide Valves. W. D. Wansbrough (*Mech Wrld*-Began March 22—2 parts to date—30 cts. each).

30617. The Making of a Bicycle. Ill. (*Engng*-Began March 22—Ended April 5—2 parts—30 cts. each).

30751. Forced Draft, and Atmospheric Condensing for Steam Power Plants. Robert D. Kinney (Eng Mech-Began April—2 parts to date—30 cts. each).

30810. Blast Pipes and Serve Tubes in Locomotives. Ill. (*Prac Eng*-Began March 29—Ended April 5—2 parts—30 cts. each).

30811. Experimental Theory of the Punching and Shearing of Metals. Ill. C. Fremont (*Prac Eng*-Began March 29—2 parts to date—30 cts. each).

30875. Fuel Oil: Comparative Results in Steam Generation. Ill. Clayton O. Billow (Elec Engng-Began April—1 part to date—15 cts).

30971. Gas Power in the American Market. Ill. (Pro Age-Began April 15—2 parts to date—15 cts. each).

31087. Losses in the Steam Engine. William A. Bole (Am Man & Ir Wrld-Began April 19—2 parts to date—15 cts. each).

31095. Method of Initial Condensation and Heat Waste in Steam Engine Cylinders. R. H. Thurston (*Ind & Ir*-Began April 12—2 parts to date—30 cts. each).

31380. The Birth and Commercial Development of the Gas Engine in America. James Schleicher (Pro Age-Began May 1—1 part to date—15 cts).

31413. Old Master Mechanics. Extracts from a Lecture by John Richards (Ind'y-Began May—1 part to date—30 cts).

31504. Modern Foundry Practice (*Engng*-Began April 26—1 part to date—30 cts).

MINING & METALLURGY

The Philosophy of Stamp-Milling.

In the *Engineering and Mining Journal* Mr. T. A. Rickard discusses the theory and practice of the wet-crushing system of gold stamp-mills. The subject is by no means so simple as might appear at first glance, and the many points brought out by Mr. Rickard cannot be even mentioned in a necessarily brief notice. One matter, however, is worthy of more attention than it often receives, especially from inexperenced graduates of the technical schools and from the "process men." The author puts it in this way: "Milling is a matter of business. The closest application of technical science may occasionally be obtained at the expense of the best commercial results. Thus, you may save 85 per cent. of the value of an ore at a cost of 80 cents per ton. By the use of further skill and added apparatus [and allowing more time] you may extract 5 per cent. more, but the value of that additional saving may be less than the actual expense, so that, while you get $3.20 out of a $4.00 ore at a cost of 80 cents, you obtain $3.40 at a cost of over $1.10. Your additional 20 cents' worth of gold has cost more than 30 cents to obtain." Substituting 80 per cent. for the assumed 85 per cent. (an evident misprint), the figures come out right.

The old controversy between the advocates of the two extreme systems of gold milling—the California and the "Gilpin county" (Colorado) methods—is approached by the author with an evident desire to be impartial. In the former system the battery is designed primarily as a crushing machine, battery-amalgamation being incidental only; and hence a heavy stamp, low drop, low discharge, narrow mortar, and high speed are the rule. In the Gilpin county mills the stamp is light, the drop high, the discharge high, mortar wide, and the speed very slow, the idea being to use the battery as an amalgamating apparatus quite as much as a pulverizer, and hence to retain the pulp in the mortar longer than is necessary for passing the ordinary screen. Mr. Rickard gives the history of the evolution of the two types, and the reasons which brought about the divergence. He considers each especially adapted to the character of the ore treated in each instance, and shows that various modifications have been made both in California and Colorado, aimed to secure the best results from ores which do not call for the use of one or the other extreme type of battery.

As to the question of substituting a crushing-concentration-shipping-smelting system for the crushing-amalgamation and subsidiary concentration of difficult pyritous gold ores, Mr. Rickard, assuming certain figures as data, holds that the former method is the more profitable. In this opinion he will not be supported by all metallurgists; but the matter hinges upon the reliability of the assumed data.

Workingmen Mine-Inspectors in France.

Socialistic agitation in Europe, which for some years has tended to shape legislation in regard to labor, has in France taken form in a movement toward the inspection and control of mines, particularly collieries, by representatives of the working miners. In 1890 a law was enacted, wholly unique in character, providing for the appointment and pay of miners, "delegates" and prescribing their powers and functions. Lately a supplementary bill has been brought forward increasing the scope of the former act. M. P. Plichon discusses, in the *Revue Universelle des Mines*, the history and working of such legislation, and his essay is translated in the *Colliery Guardian*. M. Plichon remarks that the act of 1890 shows very clearly the aim in view in the "unequal struggle between the employer and the workman," and illustrates the evolution of the social theories which are every day becoming more pronounced in Europe. The object was to assure in a large degree the safety of the men employed in mines, and under the law they have a right to choose some of their fellow-workmen or former companions, and to delegate them to visit twice a month the works in any given district. In case of death or severe injury from accident, or where the safety of the miners is endangered, the delegate may without delay visit the place where such accident has occured. The delegate enters his remarks in a register, and at once sends a copy to the prefect, who in turn reports back to the engineers of the mine. "Circuits" of inspection are established, not requiring more than six days for examination. Small workings, employing less than twenty-five men, may dispense with delegates. The pay (on basis of day's labor) is advanced by government, and by it recovered from the proprietors of the mines. M. Plichon does not believe that this law, which has not its equal in Belgium, Germany, or England, was necessitated by the frequency of mining accidents, which have been proportionately less in France than in other European countries. He also asserts that the law is of a nature rather to increase the difficulties in connection with the working of mines than to afford any greater secur ity, subjecting operations to a kind of dual control; and that popular election and the influence of miners' unions tend to partiality in the performance of the delegate's duties. He considers that the government engineers and inspectors of mines —trained men—were sufficiently numerous and capable to conduct inspections, but that the new law, by dividing responsibility, would cause the engineers to relax their zeal. Finally, he shows that the appointment of the delegates has not been the means of preventing accidents. In view of the experience had under the law of 1890, M. Plichon argues strongly against any legislation looking toward the enlargement of the functions of the miners' delegates. As the proposition to establish a system of mine-inspection by representatives of the workmen is sometimes made in the United States and other countries, M. Plichon's account of the working of the French law is very pertinent. Evidently, wherever there is already an efficient system of State inspection and control, it is undesirable to complicate and thereby weaken it. But, if it can be shown that such control is lacking, a resort to the French system would be justified only in the event of failure to secure suitable official inspection, superadded to the intelligent self-interest of the mine managers, which, after all, is the most effective safeguard.

Coal Mining Under Sydney Harbor.

It is proposed to carry into effect a project which aims at bringing from far below the lowest depths of Sydney harbor, New South Wales, the coal which geologists had predicted would be found there, and which has actually been tested by diamond-drill borings. *Transport*, in a recent issue, contains a very flattering account of the scheme now being floated on the London market, from which the following particulars are obtained. Important coal fields had been developed both north and south of Sydney,—at Newcastle and Bulli,—but up to the present the intervening area has been left practically untouched, although plainly shown on the government geological maps of 40 years ago. The unquestionable advantages which would follow the opening of coal mines in the very heart of the capital of the colony have led to the formation of a company, and induce our contemporary to take a most sanguine view of the outlook. Sydney is an important shipping port, where the lines of many steamship companies converge, and the coal of the bed in question is in demand for bunker use and export. The borings were made under the superintendence of the miners department of New South Wales, partly on account of geological interest and partly with the very practical ulterior view of raising revenue. The seam was found within 30 ft. of the depth predicted by the geologists, in a bore hole 2700 ft, deep. For 1500 ft. the borings passed through a compact sandstone, claimed to be impermeable to water. The seam itself is 10 ft. 3 in. thick, of which 6 ft. is clean coal free from band. The shafts to be sunk will be within 200 ft. of deep water, so that the situation will be unique, the saving on cost of transportation from the nearest mines now working being about 75 cents to $1 a ton. The parent company has secured a surface site of small extent, but has concessions over 1400 acres below ground (and water), and it is expected that several other collieries will be started, for which there is said to be room.

There is nothing extraordinary in mining under water, as implied in the statements from which these points are derived, as this has been done on the Cornish coast and in the copper and iron mines of Michigan, at Silver Islet, Lake Superior, and elsewhere; but the opening of great collieries in a large shipping port, with a delivery from the shaft mouth directly into vessels alongside, is something which perhaps only the mines of Washington and British Columbia can rival.

It is also proposed to utilize the small coal, screened from the bunker coal, for a large electric installation, and also to make coke and establish local smelting works.

A Year's Work in the Transvaal.

A HIGHLY creditable annual report has recently been issued by the Witwatersrand chamber of mines, showing the work accomplished by that body during 1894 and also summarizing the operations of the Transvaal gold-mining districts during that year. This institution has made itself famous for its practical, well-directed investigation of technical questions, its carefully-prepared statistics, and the influence which it has had in developing the resources of the Transvaal; and, though merely a commercial organization supported by local public spirit, its work is a model for emulation by government bureaus established to further mining interests elsewhere, and shows what can and ought to be done wherever such work is attempted. The London *Mining Journal* (April 13) contains an abstract of the report, and calls attention to the successful influence which the chamber has brought to bear upon the Boer government in antagonizing the threatened official monopoly of the cyanid reduction process and the manufacture of cyanid. It has also aimed to secure a reduction of the onerous duties on the importation of explosives, which question is still pending. A committee has been studying the relative advantages of the direct treatment (by cyanid) of tailings from the battery plates and of concentration followed by cyaniding. The majority report of this committee states that, with such a cheap process, concentration cannot usually compete with direct treatment of tailings. The minority report is to the effect that under ordinary circumstances it is generally advantageous to concentrate tailings carrying more than 4 dwts. gold, while power tailings should be concentrated direct. A geological section cutting across the 'Rand has been made, and a complete geological survey of the gold fields is urged. The statistics accompanying the report show that in 1894 the total output of all the Transvaal districts was 2,265,853 troy ounces gold (which, we believe, means bullion, not fine gold), of which the Witwatersrand produced the great bulk, or 2,024,163 ounces, as follows: From mills (amalgamation), 1,305,408 ounces; concentrates, 84,579 ounces; tailings, 587,388 ounces; alluvial, 965 ounces; other sources, 45,821 ounces. The 'Rand mills, with 2273 stamps, crushed 2,827,365 tons of ore, working 334.04 days, the average duty per stamp being 3.72 tons in 24 hours, and the yield 9.23 dwts. (£1 13s. 3d.) per ton. The 'Rand is working over more tailings now than it produces, thus drawing upon the accumulated stock; while on the other hand the slimes, about 80,000 tons of which are saved monthly, are now to be rated as an asset, in view of the expected success of new methods of treating them. Altogether the growth of the Transvaal gold-mining industry has been as remarkable as rapid. The annual yield is over $40,000,000, and in 1895 the crushing capacity will be 50 per cent. greater than in 1894.

Impurities of Commercial Aluminum.

ALUMINUM, as prepared for industrial use, has iron and silicon as its principal impurities. Besides these, there are a little carbon and some traces of nitrogen. In a communication to the *Comptes Rendus* (a translation of which, in abstract, appears in the *American Manufacturer* of March 8) M. Henri Moissan calls attention to the notable effect both carbon and nitrogen have upon the physical properties of aluminum, but says that it is to be hoped that electro-metallurgy will soon produce a metal purer and of more constant composition.

The iron alloyed in the product comes from the mineral from which the aluminum is derived and from the electrodes and crucibles used in its extraction. Although troublesome, it can be eliminated. Silicon also comes in part from the electrodes and crucibles, but mainly from the alumina employed; and the presence of this metalloid is more difficult to avert, although the amount has been easily diminished by a mere fusion of the metal under a coat of alkaline fluorid. In a footnote the author cites a case where the percentage of silicon was reduced from 0.81 to 0.37, the final product showing high elastic limit, breaking stress, and elongation. Nitrogen is easily taken up by molten aluminum, and affects it injuriously. Carbon has been found in a fixed state and in larger quantity (0.48 per cent.) than nitrogen. Tests made with samples prepared by adding crystallized aluminum carbid (made in the electric smelting furnace) to the molten metal, and comparing the product thus obtained with the same metal cast before the addition, showed that the presence of carbon greatly reduced the strength. The carbon contained in aluminum, according to this author, does not show a trace of graphite,—a rather unexpected result.

Grand Rapids Plaster Quarries.

In the April number of *Stone* Mr. C. H. Redman gives a description of the gypsum mines and quarries at Grand Rapids and vicinity. There are two underground and four open workings, including a new quarry now being stripped. The open quarries near the town are in a bed of gypsum 12 ft. thick, very nearly level, and about 7 ft. below low-water mark of the Grand river, which cuts the bed in two. The combined area of the three working open quarries is between 5 and 6 acres. The rock is covered with a variable thickness of clay, gravel, and loam, the section in one quarry there showing alternate strata of limestone, shale, and impure plaster rock varying from a few inches to 3 ft. in thickness. In two other open quarries no rock is found above the 12-ft. gypsum bed, below which are "pencil rock," shale, sandstone, and 24 ft. of impure plaster rock. The underground mines were originally opened by vertical shafts, which are now used for ventilation, but are now worked by inclines of 1 ft. in 8 or 10 ft., on which tramways are laid leading to the mills, some 200 ft. distant at the foot of the bluffs. The combined area of the two underground workings is about 33 acres. The total area of this bed is unknown, but it is thought to extend over a large territory, as it has been pierced in many places. At one point a bed of plaster rock between 20 and 30 ft. thick has been struck 80 ft. below the surface. The mines are about 130 ft. deep. A bed of from 5 to 7 ft. of gypsum lying directly above the 12-ft. bed is left as a roof. Supports of oak 12 to 24 in. in diameter are used, besides which pillars of the plaster rock 20 ft. in diameter are left standing at distances not less than 60 ft., center to center, for additional security. Blasting is done with giant powder, about 2 lbs. bringing down 8 to 10 tons of rock. Hand-drills are used. The 12-ft. bed is a pure and solid mass of gypsum, reddish at top and bluish below. In the center it is translucent, compact, fine-grained, and homogeneous, and can be taken out in large blocks. For ornamental use it is treated by a secret chemical process, sawn, and polished. In manufacturing the quarried rock it is crushed by rock-breakers and then ground by millstones or by pulverizing mills, and is then ready for use as "land plaster" for fertilizing. For calcined plaster or stucco the pulverized mineral is put into large iron kettles from 8 to 10 ft. in diameter and 8 ft. deep, and heated for 35 to 40 hours to evaporate the water. The calcined plaster is then carried by screw conveyors to bins where it is spread in thin layers to cool. The total output of the five mills is about 250,000 barrels per year.

Effects of Sulphur in Cast Iron.

In the *Iron Trade Review* of March 28 Mr. Thos. D. West made the statement that, "with proper conditions in melting, as a general thing sulphur is raised twice as much as silicon is lowered in remelting iron." In the same periodical (April 11) Mr. West recurs to the matter, and explains that the remark must not be taken to cover the action of any radical mixture which the founder may make; and he gives the results of some experiments bearing upon the question. Mr. West takes issue with Mr. Keep's deduction that the founder has no need to fear sulphur, and that cast iron will not absorb sulphur to affect its quality in being remelted. Mr. West's experiments lead him to affirm that iron will readily absorb sulphur from the fuel when being remelted, his results showing an increase of from .030 to .105 with fuel containing below 1 per cent. sulphur, the iron charged averaging about 1.60 silicon. He considers that the least variation in sulphur percentage is more effective in changing degrees of contraction and chill in an iron than a greater percentage of silicon or any other element in such mixtures as are used for making castings in general founding. "One point increase in sulphur can neutralize the effect of four to twelve points in silicon." Although sulphur may increase tensile strength, it greatly decreases resistance to deflection or elasticity, and hence excessive sulphur is to be feared, especially in light or medium machinery. One redeeming consideration about the action of sulphur is noted by Mr. West,—that, while iron has an affinity for sulphur while absorbing heat, it does not take kindly to retaining it when radiating its heat; and, if given a chance in a fluid state, sulphur will partly escape. The hotter iron is remelted and fluxed, also the longer it stands in a fluid state, the less sulphur will it contain. The top of a pig generally contains more sulphur than the bottom, according to Mr. West, owing to the sulphur being caught by the top crust in rising to escape.

Progress of the Cyanid Process.

One-quarter of the world's present output of gold, it is claimed, is obtained by the potassium cyanid leaching process. In South Africa this method of treatment has made great strides. In the United States its advance has been much slower heretofore, and, while a vast amount of experimenting has been done, it is only comparatively recently that the process has taken its place as a practical, working method on the large scale; and even yet the cyanid mills in America are not very numerous. More has been done in Colorado than elsewhere, though there are scattered cyanid plants in the other western gold-mining States. In Colorado there are several cyanid works that have been in operation for various periods of time. Now, according to the Denver daily papers of recent date, several new and large ones are being built. The decadence of silver mining has turned the attention of miners and metallurgists more to gold than ever. In that State the practice, before the introduction of cyanid treatment, has been either to amalgamate the free ores and concentrate the sulphids and ship them to the valley-smelters for reduction, or to ship the gold ore in mass to the smelters, or to concentrate (without amalgamation) and ship the gold-bearing sulphids. In either case the ore, to cover costs of local treatment, freight, and smelting charges, had to run rather high in average tenor. Hence low-grade gold ores were neglected by prospectors, or, when met in working mines, were passed by and left as a possible reserve for utilization when metallurgical advance should render that profitable. There are immense quantities of low-grade ore in Colorado and in all the gold-mining States which have not been hitherto available, but which have become so by the advent of a process costing only from $2 to $4 per ton, with fair extraction percentage. The formation of a company to build a 300-ton plant at Leadville, to treat the ores from the gold belt of that district (which is popularly known merely as a great silver-mining camp), is one of the signs of the times, and it is significant that the smelting-men have taken hold in earnest. This company, acting with some of the McArthur-Forrest people, has practically secured control of the patents on the cyanid process for the whole United States.

In this connection it may be noted that the appeal of the McArthur-Forrest Company against the adverse decision of the British royal high court of justice, made some months ago on the ground of former publication and anticipation, has resulted favorably to the appellants in effect, although the appeal was dismissed with costs. This peculiar situation results from the unfortunately broad claim that cyanid would dissolve gold. As to this the court said: "If the first claim had been disclaimed or omitted, they would not have been faced with the difficulty they were; but, as it was in the specification, they were unable to read it as the plaintiffs desired to do, and for that reason, and for that reason alone, they must with reluctance give judgment for the defendants." As to the narrower claims the court pointed out that the invention consisted not merely in discovering that cyanid of potassium could be used to extract gold from its ore, but in showing the public the best practical method of doing it, by leaving baser metals behind, which had never occured to anyone before. As to its having been anticipated by the prior specification, it would be remembered that from not one of them had any commercial result ever been attained. The claim of the United States patent, as it is well known, is narrower and more specific than this broad English claim, and is carefully limited so as to cover only a specified strength of cyanogen, which latter, it may be added, is the only kind of solution which has been found effective in this country. In this connection the following from the decision is quoted: "The selective action claimed by the plaintiffs, and the application of a very dilute solution containing an extremely small quantity of cyanid of potassium to ore containing gold, had, in the opinion of their lordships, been proved."

THE ENGINEER reprints from a Chicago newspaper an account of the borax industry in California and Nevada, from which it appears that borax crystals are no longer dug in quantity from the borax marshes, because a more abundant supply is found in the borate of lime impregnating rock, which is obtained by regular mining. The borax region is destitute of water and fuel, entailing great difficulties and hardships to the men. The crude brown "ore" is hauled long distances across the desert in broad-tired wagons to the railroad, and thence taken to the refineries, one of the largest of which is on San Francisco bay, several hundred miles distant.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*30840. The Advances in Modern Iron Smelting. Ill. John Birkinbine (Eng Mag-June.) 3000 w.

30851. Melting Gray Iron with Natural Gas. Ill. Burt H. Whiteley (Ir Age-April 11.) 700w.

30907. The Hardening of Steel. Abstract from M. C. Charpy (Eng & Min Jour-April 13.) 800 w.

30908. Determination of Tungsten. F. Cremer (Eng & Min. Jour-April 13.) 600 w.

30980. Effects of Sulphur in Cast Iron. Thomas D. West (Ir Tr Rev-April 11.) 1200 w.

31012. The Fatigue of Metals. P. Kreuzpointer (Ir Age-April 18.) 2200 w.

31015. Utilization of Blast Furnace Cinder. S. Norton (Ir Age-April 18.) 800 w.

†31073. The Wet Assay for Copper. R. S. Dulin (Jour Am Chem Soc-May.) 1800 w.

†31075. The Determination of Sulphur in Pyrites.—A Reply to Dr. Lunge. Thomas S. Gladding (Jour Am Chem Soc-May.) 1500 w.

†31076. The Zimmermann-Reinhardt Method for the Determination of Iron in Iron Ores. C. T. Mixer and H. W. DuBois (Jour Am Chem Soc-May.) 1600 w.

31089. The Decision of the English Court of Appeals in the Cyanide Case (Eng & Min Jour-April 20.) 1100 w.

31091. The Iron Industry of France—1893 (Eng & Min Jour-April 20.) 1500 w.

31092. Copper Assaying at Lake Superior. G. L. Heath (Eng & Min Jour-April 20.) 1500 w.

31233. Treatment of Ores in the Cooney Mining District, New Mexico. Carl Anderson (Eng & Min Jour-April 27.) 1000 w.

†31236. The Iron Situation in the United States. A. I. Findley (Bank Mag-April.) 5500 w.

31242. xpansion of Cast Iron in Solidifying. E. D. Estrada. Read before the Eng. Soc. of W. Penn. (Ir Tr Rev-April 25.) 1300 w.

*31287. Ten Years Progress in the Metallurgy of Copper. Henry W. Edwards (*Min Jour*-April 20.) 2600 w.

*31334. The Cyanide Patent Case. Editorial (*Eng*-April 19.) 1500 w.

31392. Silver Alloys. G. J. Fowler and P. J. Hartog, with Discussion (Sci Am Sup-May 4.) 2300 w.

*31404. The Development of the Russian Metallurgical Industry (*Bd of Tr Jour*-April.) 700 w.

†31440. On a New Method for the Separation of Copper and Cadmium in Qualitative Analysis. Allerton S. Cushman (Am Chem Jour-May.) 1500 w.

31459. Is the Use of Cyanide of Potassium for Gold Extraction Common Property? Letter from E. Andreoli (Eng & Min Jour-May 4.) 2500 w.

31460. Two Interesting Cases of Abnormal Condition in Pig Iron. (Abstract.) T. W. Hogg (Eng & Min Jour-May 4.) 1200 w.

*31506. Coal and Coke in Upper Silesia, with Some Observations on the Rational Utilization of Coke Oven and Blast Furnace Gases. Alexandre Gouvy (*Col Guard*-April 26.) 4500 w.

31532. Milling Arizona Gold Ores with a "Colorado" Stamp Mill. Willard S. Morse (Min Ind & Tr-May 2.) 1200 w.

31533. A New Departure for Steel. Editorial (Age of St-May 4.) 700 w.

31547. Remarkable Decline in Iron and Steel Prices. From the London Economist (Ry Age-May 3.) 1000 w.

*31564. Some Historical Notes on the Hot Blast. Ill. A. Humboldt Sexton (*Ir & Coal Tr Rev*-April 26.) 3800 w.

31594. Accurate Milling. Ill. Horace L. Arnold (Am Mach-May 9.) 1800 w.

Mining.

*30839. Wooden Stave Pipe for Conveying Water. A Novel Expedient of the Mining Regions. Arthur Lakes. (Eng Mag-June.) 3000 w.

30870. The Largest Piece of Gold Yet Found Was Worth Nearly $150,000.—Other Nuggets. Argus (Min & Sci Pr-April 6.) 500 w.

*30896. The Grand Rapids Plaster Quarries. C. H. Redman (Stone-April.) 1400 w.

30906. The Cooney Mining District, Socorro Co., New Mexico. Ill. Carl Andersen (Eng & Min Jour-April 13.) 1000 w.

30978. Borax Mining.—From Chicago Record (Eng-April 13.) 700 w.

*30982. Aiseau-Presle Colliery, Farciennes, Charleroi (*Col Guard*-April 5.) 5400 w.

*30983. Working-Men Mines Inspectors in France. P. Plinchon (*Col Guard*-April 5.) 2000 w.

*30984. The Fire and Gas Explosion at the Blanzy Colliery, France (*Col Guard*-April 5.) 1600 w.

*31008. Historical Notes on Early Plans for Coal Washing. F. J. Rowan (*Aust Min Stand*-March 2.) 1200 w.

*31023. Diamond Washing and Concentration (*Min Jour*-April 6.) 1800 w.

*31025. The Mineral Wealth of Nova Scotia. Editorial (*Min Jour*-April 6.) 1300 w.

31079. Description of the Gold Belt of California. H. W. Turner (Min & Sci Pr-April 13.) 3800 w.

*31135. A Year's Work in the Transvaal (*Min Jour*-April 13.) 3000 w.

31197. Red Rock, Goler and Summit Mining Districts in Kern County. Ill. (Min & Sci Pr-April 20.) 900 w.

31234. Auriferous Conglomerate in California. Harold W. Fairbanks (Eng & Min Jour-April 27.) 1500 w.

†31237. Gold Fields of Africa. Hamilton Smith, in the London Times (Bank Mag-April.) 3800 w.

*31249. Randt Mining in the Past Quarter. Editorial (*Min Wrld*-April 20.) 1200 w.

*31289. Gold Mining Progress in California. Editorial (*Min Jour*-April 20.) 2000 w.

*31291. Alaska.—Facts about the Yukon. Wilbur F. Cornell (Min Rev-April 26.) 1200 w.

*31327. The Courrieres Collieries, Pas-de-Calais, France (*Col Guard*-April 19.) 1800 w.

*31329. Merionethshire Slate Mines (*Col Guard*-April 19.) 3500 w.

31353 An Interesting Placer Plant. Ill. (Min Ind & Tr-April 25.) 1500 w.

31395. The Early days of Petroleum. From the New York Tribune (Ir Age-May 2.) 2700 w.

*31399. Coal Dust as an Explosive Agent. Donald M. D. Stuart (*Jour Gas Lgt*-April 23.) 1000 w.

31454. A New Use for the Air Caisson. Ill. F. E. Nettleton (Min & Sci Pr-April 27.) 500 w.

31457. Oil in the South (Mfrs Rec-May 3.) 1000 w.

31458. The Copper Production of the United States in 1894 (Eng & Min Jour-May 4.) 700 w.

31461. The Ammon Mines, Fergus County, Mont. H. C. Freeman (Eng & Min Jour-May 4.) 900 w.

*31508 The Inundation of Mines (*Col Guard*-April 26.) 3500 w.

*31517. Southern Cross, Western Australia. Brenton Symons (*Min Jour*-April 27.) 2500 w.

*31519. The Osceola Mine. Description of a Noted Copper Mine. Ill. (Col Eng–May.) 2800 w.

*31522. Interesting Mining History.—The First Exhaust Fan Used at an American Coal Mine. Thomas H. Walton (Col Eng–May.) 1800 w.

*31523. The Sand Coulee Mines. J. L. Parker (Col Eng–May.) 2000 w.

31537. The Corundum Deposits of Georgia. William M. Brewer (Tradesman–May 1.) 3800 w.

31552. Gold Mining in British Columbia. From Report of Dr. George Dawson (Can Min Rev–April.) 4000 w.

31553. Characteristics of Explosives. William Glenn (Can Min Rev–April.) 3200 w.

31554. Gold Mining in the County of Beauce, Que. W. Prideaux (Can Min Rev–April.) 1500 w.

31555. Explosion by Lightning at a Nova Scotia Colliery. From a paper by T. Farmsworth (Can Min Rev–April.) 2000 w.

31556. Determining the Value of Gold Ores in the Field. R. W. Leonard (Can Min Rev–April.) 700 w.

31557. A Recent Trip to the Rainy River Gold Fields. F. Hille (Can Min Rev–April.) 2300 w.

Miscellany.

30905. The Superficial Alteration of Ore Deposits. Abstract with Editorial. R. A. F. Penrose, Jr. (Eng & Min Jour–April 13.) 3500 w.

31090. New Apex and Tunnel Decisions. Francis T. Freeland (Eng & Min Jour–April 20.) 2000 w.

*31129. The Mining and Metallurgical Industries of Finland (*Ir & Steel Tr Jour*–April 13.) 1100 w.

*31406. Mining and Metallurgical Industries of Spain (*Bd of Tr Jour*–April.) 700 w.

31551. The Mineral Resources of Cape Breton. Editorial (Can Min Rev–April.) 1200 w.

Serials.

20413. Mining Methods. Ill. (Col Eng–Began March, 1894—15 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (Col Eng–Began March, 1894—15 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (Col Eng–Began March, 1894—15 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (Col Eng–Began March, 1894—15 parts to date—30 cts. each).

22586. The Mineral Hydrocarbons (Min & Sci Pr–Began June 2, 1894—27 parts to date—15 cts. each).

27329. Coal Mining Economy Up to Date. Ill. (*Ir & Coal Tr Rev*–Began Nov. 23, 1894—13 parts to date—30 cts. each).

28786. The Mineral Wealth of Siberia (*Min Jour*–Began Jan. 19—Ended April 13—11 parts—30 cts. each).

29468. The Cyanide Process.—Its Practical Application and Economical Results. A. Scheidel (*Min Jour*–Began Feb. 9—11 parts to date—30 cts. each).

29599. Mining in Spain. (Asturias.) (*Min Jour*–Began Feb. 16—3 parts to date—30 cts. each).

29939. Pocket Hunting in California. W. H. Storms (Min & Sci Pr–Began March 2—3 parts to date—15 cts. each).

30009. Down in a Belgian Coal Mine. B. Lippens (Can Eng–Began March—Ended April—2 parts—15 cts. each).

30047. Prospecting.—Where and How to Find Gold and Silver Veins and Deposits. Ill. Arthur Lakes (Col Eng–Began March—3 parts to date—30 cts. each).

30049. Mine Surveying.—Latest American Ideas and Most Approved Practice. Ill. Edward B. Durham (Col Eng–Began March—3 parts to date—30 cts. each).

30214. Modern Coke Making. William Bowron (Tradesman–Began March 15—3 parts to date—15 cts. each).

30459. Modern Furnace vs. Cupola Practice. Thomas D. West (Am Mach–Began March 28—2 parts to date—15 cts. each).

30461. The History of Iron. Ill. From Dr. Ludwig Beck (Ir Age–Began March 28—4 parts to date—15 cts. each).

30484. Characteristic Features of California Gold-Quartz Veins. Waldemar Lindgren (Min & Sci Pr–Began March 23—Ended April 20—3 parts—15cts. each)

30791. Gold Mining in Wales (*Min Jour*–Began March 30—Ended April 13—3 parts—30 cts. each).

30815. Furnaces for Roasting Gold-Bearing Ores. Ill C. G. Warnford Lock (*Ir & Coal Tr Rev*–Began March 29—Ended April 5—2 parts—30 cts. each).

30912. The Glasgow Iron and Steel Company's Works, Wishall. Ill. (*Engng*–Began April 5—2 parts to date—30 cts. each).

30962. Some Suggested Economies and Improvements in the Manufacture of Bar, Hoop and Sheet Iron; Having Special Reference to the Fuels Used and to the Furnaces Employed. Ernest W. Harvey (*Ir & Coal Tr Rev*–Began April 5—Ended April 26—4 parts—30 cts. each).

31107. The Luxemburg Iron Industry. J. Walter Pearse (*Col Guard*–Began April 11—Ended April 26—3 parts—30 cts. each).

31148. Bath Stone. Ill. (*Builder*–Began April 13—Ended April 20—2 parts—30 cts. each).

31330. Colliery Surface Works. Ill. Edward Brownfield Wain (*Col Guard*–Began April 19—2 parts to date—30 cts. each).

31511. The Tin-Plate Industry in the United States (*Eng*–Began April 26—1 part to date—30 cts).

MUNICIPAL ENGINEERING

A Plea for Contractors.

"MUCH mistrusted class," Mr. Charles A. Ewing, in *Paving and Municipal Engineering* for May, styles contractors. Moreover, he charges that this is the fault of the engineering profession itself. He argues for an extension of engineering ethics to contractors, which he styles the "other half" of the profession, and alleges that the evil can be easily remedied "by drawing up reasonable specifications," and simpler forms of contracts, "less autocratic, less dictatorial, less theoretical, less unnatural, less unreasonable. It is these alleged faults to which the mistrust of contractors is attributed.

"As to our first proposition, every engineer knows—in fact, the public at large knows—that a contractor will not do anything that he is not made to do; that he takes no special pride in his work; that he does nothing unforeseen or unspecified without extra charge; that the construction is carried on largely as a warfare; that in the preparation of specifications for any work the engineer lies awake at night wondering if he has left 'anything out,' and every day he is in dread of having his assistants or inspectors report at the office a case of failure to comply with specifications as regards material or workmanship, placing him under the painful necessity of becoming judge, jury, and executioner in dealing with the refractory contractor. Every engineer knows the great effort he makes to secure good bonds and to make a contractor thoroughly responsible. He knows that there is a sigh of relief when the work is done, although it is only approximately as well done as his specifications called for; in short, every one knows, including the contractor himself, that it is believed that he will beat you, if he can."

Specifications are too wordy, too much detailed, too elaborate; in short, they "are generally more faulty than the structure itself, and generally so full of provisos, arbitrary powers delegated to one party, and unnatural responsibilities laid on the other party, so full of bonds, acknowledgments, etc., that the contractor, thus given the suspicion and bad name in the start, generally deserves it in the end. Specifications are seldom read by the contractor until he commences work on the contract. This shows how little attention he pays to what has been carefully prepared. The first thing that strikes the eye in looking at the specifications is some glaring headline in red ink, telling him that 'prices must be written in words as well as in figures,' implying that he does not know how to write, and that his 2's may look like 4's, and his 3's may look like 8's. Or it may be that 'contractors are requested to notice any changes and insertions that may have been made in the specifications before depositing their bids,' thus telling the contractor plainly that the engineer has changed his mind or made some mistake. Or it may be in a redder red ink that 'bidders must accompany bids with a bond of so much,' etc., giving him to understand that his business career of a lifetime, his well-known work, his individual character, are as nothing compared to two men who are willing to sign their names for so much money. Then he turns the page, after some statements as to when the bids will be received, and finds 'Bonds A' and 'Bonds B,' with several blank notary acknowledgments as to his bondsmen being resident freeholders, and that he is held to commence the work, and that his bid cannot be withdrawn, although the 'right to reject any or all bids' is reserved by the other party. Then comes an approximate estimate of quantities, followed by a 'form of proposal,' and all before he has reached the specifications, which should precede the form of proposal, in order to enable him to know how to propose." Objectionable clauses and stereotyped phrases in specifications are the following: "The right to alter and to increase or decrease quantities"; "under the direction of, and to the satisfaction of, the engineer"; "the contractor will be held responsible for all damages"; "no extra work will be paid for, unless ordered in writing"; "incompetent workmen must be dismissed at the request of the engineer or inspector."

The requirement recently inserted in specifications for municipal contracts in Cincinnati and other municipalities that persons employed shall have been residents of the city for a special time is severely, but justly, criticised, and held to be no more reasonable or justifiable than that the contractors also shall have been residents for a specified time. "Letting to the lowest bidder is wrong . . . . The right to reject any or all bids is an injustice. . . . . Work should be let to the lowest responsible bidder. . . . . Engineers should give advice as to best time, place, and methods of doing the work, as if they had the interest of a partner in the success of the work."

More About Calcium Carbid.

MESSRS. F. P. VENABLE and Thomas Clarke, of the University of North Carolina, have been experimenting with this substance in order to determine its reactions with various other substances. Some of the results obtained have been verified by Mr. W. R. Kenan. These results are contributed to *American Gas Light Journal* (April 15) by the first-named investigators. In view of the anticipations that have been raised that calcium carbid would enter into commerce as a source of the illuminant acetylene formed by the reaction of water on the carbid, the information given is timely and interesting.

"The calcium carbid used was prepared by the Wilson Aluminum Company. In this preparation lime is mixed with some form of carbon, as coal tar; the mass is then heated, with stirring until a thorough mixture is obtained. The proportions are so arranged that the mass becomes dry and hard on cooling. This mass, in lumps, is then placed in the electric furnace. In a very short time after the turning on of the current the process is complete. The molten mass can be run out of the crucible, or it may be removed after cooling. On examination it is easy to see that there is more or less of carbon unchanged, or rather converted into the graphic variety by the intense heat. Along with this are to be seen crystalline masses, lustrous and dark brownish black in color. These are quite hard, and break with a crystalline fracture. Several efforts at effecting a separation from the graphitic carbon were unsuccessful. The luster is slowly lost on exposure to air, more rapidly if the air be filled with moisture. The whole will finally crumble down into a gray powder with particles of black graphite interspersed through it. The carbid can be kept for a year or two, if placed in a tightly-stoppered bottle, and is quite easily preserved, if a little coal-oil is placed in the vessel containing it. If the gas as evolved (by the reaction of water upon it) is passed through a set of absorption flasks containing ammoniacal copper solution, it will be entirely absorbed,—not a bubble passing through, out of 1 or 2 liters of the gas. Thus it seems to be pure acetylene. The amount of gas yielded by any one sample will be affected to some extent by the amount of graphitic carbon present. Hence different lots will vary somewhat. The average is about 200 c. c. to the gram of carbid."

The gas so obtained burns with a fuliginous flame, but, if diluted with from six to ten parts of air, it generates a white flame of great illuminating power. Some caution is necessary to prevent accident with this gas. Like all highly-combustible gases, it forms an explosive mixture with air, and, if too large a proportion of air be mingled with it, a very violent explosion can be obtained by igniting it.

Dry hydrogen in the cold has no action upon calcium carbid. A reaction takes place when the hydrogen is ignited, the non-luminous hydrogen flame then becoming luminous. A tarry matter results. Dry air and oxygen also generate a luminous flame when passed over the hot carbid, with a similar production of tarry matter. Hot hydrochloric acid causes the carbid to swell and turn a dirty gray; in the cold it gives no reaction. The reaction with chlorine and bromine is curious. Neither of these react when cold. Chlorine, when passed over heated lumps of the material, causes them to glow brightly, to swell, and to fuse together. In this experiment some of the carbid sublimates. The sublimate has a yellowish-white color. When subjected to similar treatment with bromine, the carbid turns red and glows, the lumps fuse together, bubbles indicate the escape of some sort of gas, and calcium bromid is formed. Strong sulphuric acid, when heated with the carbid, produced a gas that burned with a luminous flame; but, when potassium bichromate was presented to the carbid, no acetylene was generated. The action of alkalies also produces a gas supposed to be acetylene.

Park or Grove.

MR. F. A. WAUGH, in *Garden and Forest* (April), says that "there are very few real parks in western towns, unless delightful bits of virgin scenery are to be accepted under that head. The pleasure-grounds where, with natural conditions more or less propitious, an intelligent art has wrought any satisfying or pleasing effect are exceedingly rare. At the same time there are not wanting hundreds of attempts in this direction. Almost every prairie town of any consequence at all has its so-called park. Sometimes this park and the fair-grounds are combined. Whether this park be fair-grounds, race-track, or plain park, however, the location is usually upon some thoroughly flat, featureless, and treeless place, where the city council and the street commissioner can give their creative instincts full swing. This park is laid out in intricate and wonderful patterns. It contains race-tracks, baseball-grounds, camp-meeting-stands, carp-ponds, fountains, or fences, according to the whims of the street commissioner and the demands of the populace. It is profusely set with trees, cottonwoods having a large majority, and these are then left to struggle with a magnificent annual crop of sunflowers. This picture is not in the least overdrawn. Any one who has ever lived in the west knows it to be the sober truth. As a consequence of the construction and maintenance of this park, it is unfrequented and neglected. If the county fair is held on the grounds in the fall, the sunflowers are mowed, and for three days the park is crowded and useful.

"Now, it is a strange companion picture to this which one sees if he visits 'The Grove.' Near most towns will be found pieces of natural woodland, usually along some stream, to which the picnic parties always turn with natural impulse, which largely discredits their ill-conceived ideas of a park. Every town has its 'Wilson's grove' or 'Johnson's grove,' which is a place of this sort,—virgin woods and streams and rocks, unmarked by any attempt at art. This is the place to which the citizens all retreat when the appetite for fresh air and shade and out-door rest is to be satisfied. The name 'grove,' as applied to the picnicing rendezvous, in contradistinction to the park, is one of interest. These terms are commonly accepted and used with the utmost clearness of distinction, showing that in the popular mind the two articles are in no way related. Nevertheless, it would appear at once to the artist in landscape that the grove is by far the more satisfactory park. And, were the parks of western cities planned by landscape-artists, there is no doubt but that they would usually be located where unperverted instinct has found a satisfying grove, and seldom or never where false instruction has led citizens to make their so-called parks."

The unspoiled instinct for sylvan pleasures is demonstrated by the favor in which the grove is held, while the park, though showing the public spirit and liberality of the citizens, shows also their utter inappreciation of what a park could be made, if the expenditures that are freely bestowed upon the combined baseball-grounds and sunflower-patches were directed to improve the groves.

Pollution of Water-Supply.

A REPORT presented by a committee of the American Health Association at a meeting of that body in Montreal, and printed in the *Sanitary Record* (April 13), reviews a previous report that threw serious doubts upon the sufficiency of any known artificial method of purifying town water-supply to which sewage has had access, and presents a different view based upon further study of filtration as now carried out by improved processes both in America and Europe. The prior report said: The bacteria of nitrification cannot be harnessed to the work of artificial filtration, and hence the results of such methods, although manifesting a satisfactory freedom from suspended matters, will in no instance compare with the organic purity which characterizes the spring and well-waters that are found in the laboratory of nature."

In the same document: "when the committee came to consider the specific matter of typhoid fever in a sewage-polluted water, it was equally positive that artificial filtration could not remove or destroy this infection. The committee recognized typhoid fever propagated by well-waters that had undergone a more efficient filtration through the soil than is effected by artificial filter-beds; and the story of the Lauzen epidemic seemed to indicate that a long subterranean course failed to remove the bacilli of typhoid fever."

The great work of the board of health of Massachusetts, the researches of Prof. Koch, the report of a royal commission on the water-supply of London, and other investigations seem to have completely upset the opinions expressed in the former report. The strongest argument in favor of filtration is summarized from the report of the local government board of London. "According to laboratory experiments, the bacillus of typhoid seldom retains its vitality in fecal matter for more than 15 days. The ordinary water bacteria, thriving in their natural habitat, deprive the intruding pathogenic bacilli of the conditions favorable to their development. They undoubtedly exert an influence in diminishing the vitality of the typhoid bacillus, either actually consuming it, or, as is more probable, giving rise to products that interfere with its growth. The diminished temperature of the water as compared with that of the human body is another unfavorable condition; and the sedimentation of suspended matters is such, particularly in storage reservoirs, as to carry down with them three-fourths, five-sixths, or even larger proportions of the bacteria present. Fourth, the vital action of filter-beds removes or destroys any pathogenic organisms. A new filter of perfectly purified sand has little effect in producing either chemical or bacteriological purification, but, in course of use, a layer charged with living microbes is deposited on the surface and it is by these organisms, which constantly increase in number and also penetrate the sand to a slight distance, that nitrification and the arrest of other microbes are effected. Hence the longer a sand filter has been used, the more efficient it becomes, provided it does not become so dense on its surface as to prevent the satisfactory passage of the water. This filtration by the London Water Company removes 98 or 99 per cent. of the microbes contained in the river water. Again, so far as regards pathogenic bacteria, not only has no such organism been found in the river-water, but none was found in the gelatinous layer of living microbes from the surface of a Pasteur-Chamberland filter after the passage of a considerable volume of raw river-water. The risk of the propagation of typhoid fever by the filtered metropolitan water is, therefore, regarded as very small. Moreover, it must be remembered that small doses of the typhoid bacillus may probably be swallowed with impunity by a healthy person, the bacilli entering the system being destroyed by the secretions or living cells of the alimentary canal before they are able to establish themselves."

Notation for Plans of Water-Supply.

AT a meeting of the Engineers' Club of Philadelphia, March 16, Mr. W. H. Dechant described a system of graphically indicating sizes of pipes on plans, which seems to be a useful innovation. This was used with success in plans for the water-supply systems of Reading, Pa. By it the size of any pipe can be seen at any point. In the Reading plans the sizes of pipes ranged from 4" to 24". "Taking the size of pipes in inches, and assuming the inches as representing feet, broken lines are drawn, the blocks or dashes of which are drawn to scale five times the diameter of the pipes, in length, by the diameter of the pipe, in width. For example: For a 24-in. pipe, dashes were made to scale 120 ft. long by 24 ft. wide. For a 10-in. pipe the scale was 50 ft. long by 10 ft. wide. The spaces between these dashes were made equal to the length of dashes, and in these spaces were marked in Roman numerals the size of pipe."

The advantages of this plan are: "(1) Looking on the whole map or plan, the various sizes of pipe are presented graphically, showing at once the location of the large and small pipes. (2) The marking of the size all along the length at close intervals is very important where the sizes frequently change, and enables the size to be seen at once, without any reference to color or a following of the line to find a size mark. (3) The pipe-lines thus made are also peculiar and distinctive, making them easy to follow among the other lines or plans. The plans were to a scale of 290 ft. to an inch; these were reduced by photo-lithography so as to make them nearly 1000 ft. to an inch; even at this scale the sizes of pipes can be read with the naked eye."

Steam Street Railways in Italy.

THE *Street Railway Review* for April notes the fact that Italy is in advance of the United States in the use and development of suburban and interurban street railways for carrying freights. These lines are operated principally by steam, and they carry all sorts of things into and out of the cities, and from point to point within the city limits. These roads in suburban districts have sidings branching into private property, thus establishing "direct communication with farms, fruit-gardens, dairies, milk, factories, ironworks, brickworks, lime-kilns, quarries, and mines."

At Vinovo the fæcal matter from the town is thus conveyed to surrounding lands, upon which it is used for fertilization. The freight traffic on these lines had a remarkable development. The advantages resulting are important. "The cars are loaded on the spot, and freights are delivered without rehandling." For example, bricks "are received at Turin from the large yards at Beinasco in the original crates in which they were stacked in the field." "Curves have a radius of 55 yards, as a rule, although there are some of 20 and 40 yards. On the sharper curves the gage is slightly eased, and, as the rigid wheel-base is only 5 ft. 3 in. from axle to axle, the cars and locomotives readily pass. Gradients are very steep in some localities, but in only one place has resort been had to a rack rail. Single track forms nearly the entire mileage, double track occurring only on trunk lines used by different branches. The turn-outs are 360 ft. in length, giving 200 ft. clear track. Stations for the sale of tickets are usually located at the more important stopping-places in houses adjoining the track.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Gas Supply.

*30891. The Improvement of Lighting Duty (*Jour Gas Lgt*–April 2.) 2000 w.

*30892. The Action of Heat Upon Ethylene. Vivian B. Lewes (*Jour Gas Lgt*–April 2.) 1800 w.

*30893. The Composition of the Extinctive Atmospheres Produced by Flames. Frank Clowes (*Jour Gas Lgt*–April 2.) 900 w.

*30894. Mr. John West on Economical Lighting (*Jour Gas Lgt*–April 2.) 4000 w.

30969. Some of the Properties of Calcium Carbide. F. P. Venable and Thomas Clarke (Am Gas Lgt Jour–April 15.) 1500 w.

*31033. Address of Alexander Yuill at the Informal Meeting of Scottish Gas Managers, with Discussion (*Jour Gas Lgt*–April 9.) 9500 w.

*31034. The Labor Saving Plant at the Saltley (Birmingham) Gas Works. Ill. Henry Hack (*Jour Gas Lgt*–April 9.) 4000 w.

*31332. On the Safe Storage and Conveyance of Compressed Gases. H. Joshua Phillips (*Eng*–April 19.) 1500 w.

*31352. Gas in Bottling Stores. Thomas Fletcher (*Gas Wrld*–April 20.) 1500 w.

†31566. The Carbides and Acetylene Commercially Considered. Ill. T. L. Wilson and J. J. Suckert (Jour Fr Inst–May.) 6500 w.

31592. Radiant Tissue for Incandescent Gas Lamps. Ill. F. De Mare (Sci Am Sup-May 11.) 500 w.

Sewerage.

*31414. Sewerage in Foreign Cities. C. W. Chancellor (Ind'y-May.) 2000 w.

*31444. Some Special Sewer Construction. Ill. E. Hill (Paving-May.) 900 w.

31465. Sewage-Disposal System, Reading, Pa. Ill. (Eng-Rec-May 4.) 1200 w.

†31480. Sewerage in Foreign Cities. C. W. Chancellor (San-May.) 6000 w.

Streets and Pavements.

*30897. Stone in Street Construction. I. C. U. (Stone-April.) 700 w.

30949. Road Building. Extract from lecture of F. V. Greene (Eng Rec-April 13.) 2000 w.

31043. Standard Tests of Paving Brick. J. B. Johnson (Eng News-April 18.) 3200 w.

31044. Recent Paving Brick Tests (Eng News-April 18.) 700 w.

*31156. Pavements of Cleveland, Ohio, Compared with Those of Other Cities. James Ritchie, with Discussion (Jour Asso Eng Soc-March.) 6000 w.

Water Supply.

30879. The New Steel and Masonry Water Supply Conduit, Rochester, N. Y. Ill. (Eng News-April 11.) 7000 w.

30881. A Method for Determining the Supply from a Given Watershed. Ill. James L. Greenleaf (Eng News-April 11.) 1800 w.

31046. The New Water Works System of Ottawa, Ill. Ill. (Eng News-April 18.) 900 w.

31048. Available Yield from Proposed Drainage Area of the Jersey City Water Company-Letters from Contractor and C. C. Vermeule (Eng News-April 13.) 1800 w.

31138. Testing Cast Iron Water Conduits. Ill. R. A. Cairns (Eng Rec-April 20.) 2500 w.

31139. The Mueggel Lake Water Filters (Eng Rec-April 20.) 2300 w.

*31143. Report of Committee on Pollution of Water Supplies. Charles Smart (*San Rec*-April 13.) 5000 w.

31205. Water Supply of North-Eastern New Jersey and the New Jersey Bid. Editorial (Eng News-April 25) 4000 w.

31225. The Prevention of Ice at Intakes. Conclusions of Edward B. Guthrie (Eng Rec-April 27.) 1800 w.

*31340. The London Water Companies; Their Rights and Dangers (*Jour Gas Lgt*-April 16.) 1600 w.

31428. Specifications for Stand Pipes.-Letters from Freeman C. Coffin and William R. Webster. Ill. (Eng News-May 2.) 2700 w.

†31479. Household Water Supply. J. C. Chase (San-May.) 3300 w.

†31495. A Problem in Hydrostatics and Its Ingenious Solution. Ill. C. H. Ott (Pro Eng Club of Phila-April.) 1200 w.

31610. Failure of the Angel's Masonry Dam, Calaveras County, Cal. Ill. (Eng News-May 9.) 1200 w.

31612. Failure of the Dam of the Bouzey Reservoir in France (Eng News-May 9.) 800 w.

Miscellany.

*30835. The Ideal City Engineering Bureau. Francis Collingwood (Eng Mag-June.) 3000 w.

*30836. Problems in Providing a Water-Supply. Ill. Rudolph Hering (Eng Mag-June.) 3000 w.

30874. Municipal Industrial Schools. John G. McMynn (Elec Engng-April.) 1000 w.

†30989. Glasgow—A Model Municipality. W. E. Garrett Fisher (*Fort Rev*-April.) 8000 w.

*31178. Municipal Government in England. Edward Porritt (Chau-May.) 4000 w.

*31179. Queer Customs of the City of London. J. C. Thornley (Chau-May.) 3300 w.

†31273. A Chapter of Municipal Folly—The Squandering of New York's Public Franchises. A. C. Bernheim (Cent Mag-May.) 2800 w.

31397. The Metropolitan Parks of Boston. Editorial (Gar & For-May 1.) 1500 w.

31403. Park vs. Grove. F. A. Waugh (Gar & For-April 17.) 800 w.

*31443. System of Records in a City Engineer's Office. William Steyh (Paving-May.) 2000 w.

*31445. The New Department of Public Works in San Francisco. C. E. Grunsky (Paving-May.) 900 w.

*31502. New Drainage Works in Paris. Ill. (*Engng*-April 26.) 3500 w.

Serials.

5358. Sewage Purification in America. Ill. (Eng News-Began July 14, 1892—45 parts to date—15 cts. each).

24751. The Gas Manager Abroad (*Gas Wrld*-Began Aug. 25, 1894—13 parts to date—30 cts. each).

28265. Frontinus on the Water Supply of Rome, A. D. 97. Clemens Herschel (Eng Rec-Began Jan. 5—Ended May 4—7 parts—15 cts. each).

30930. Economical Lighting of Buildings and Workshops. John West (*Prac Eng*-Began April 5—Ended April 12—2 parts—30 cts. each).

30948. The New Rochester Water Works. Ill. (Eng Rec-Began April 13—4 parts to date—15 cts. each).

31082. Water Supply and Pipe Distribution. F. C. Moore (Fire & Water-Began April 20—3 parts to date—15 cts. each).

31137. Raising Water by the Air Lift (Eng Rec-Began April 20—1 part to date— 15 cts).

31204. Stand-Pipe Accident and Failures—Appendix to Series of Articles Concluded June 7, 1894. William D. Pence (Eng News-Began April 25—Ended May 2—2 parts—15 cts. each).

RAILROADING

Hard Times and the Railroads.

A STAFF writer of *The Peterson Magazine* has compiled an array of facts from railway statistics which forms part of a paper under the above title. The article is spun out by brief biographical sketches of railroad men, which, however interesting in themselves, do not seem entirely consonant with the title. Only the statistical part of the article will be herein considered. This presents to the general reading public the extent to which the railroads of the country have felt the hard times, and it will be a good corrective to the too prevalent notion that the railroad interests are growing rich at the expense of all other industries. The figures given indicate that only by the rigid reduction of expenses through sweeping economies have the roads fortunate enough to keep out of the hands of receivers been able to make ends meet.

In the midst of the strain upon the carrying capacity of many lines caused by the World's Fair at Chicago, and after large expenditures to meet the unusual conditions, the business panic came like a cyclone. This was followed by the great strike at Chicago, which not only caused a decrease of earnings, but entailed an unexpected and unusual expense upon some of the most important railways. The failure of crops followed, with consequent diminution of freight traffic. As usual in times of business depression, the railways suffered out of proportion to other industries. More than this, they still suffer from the effects of the prolonged commercial stagnation, and will continue to suffer after other industries are restored to health.

Figures taken from the report of the Interstate Commerce Commission show "that the year ending June 30, 1894, witnessed a falling off of $840 per mile in the gross revenues of 570 roads, representing 149,559 miles of operated line. As there are about 179,000 miles of operated line in the whole country, the same proportion of decline would show a falling off in the gross income of all the roads, for that year, of over $150,000,000. The same report shows that there was a shrinkage of $3,999,169 in the dividends paid on these 570 roads as compared with the dividends paid the year before. And, finally, it is shown that, after the payment of expenses and dividends, there was a total deficit of $28,255,121 in the accounts of these roads, which was tabulated in the column usually headed 'surplus.' The heaviest falling off in dividends occurred in the Southern States, east of the Mississippi river, and in the States along the Pacific coast."

As yet no official statistics are available to show the losses in 1894 due to the failure of crops and the strikes. The *Financial Chronicle* is, however, quoted to show the falling off in "the gross receipts of the leading railways . . . for the last six months of 1894," which paper estimates the decrease to be $20,000,000, as compared with "the last six months of 1893." For the whole year and for all the roads it is estimated that the total decrease in gross income will not fall short of the enormous sum of $163,000,000.

Of course such a decrease had to be met by corresponding economies, or all the railroads would have been financially ruined, like the weaker ones for which receivers have been appointed.

"The economies practised by the various railways have been an astonishment. The New England roads, with a decline of over $2,500,000 in gross income, actually reduced their expenses so greatly that their net income showed an increase of $2,200,000. As to the whole 206 roads tabulated, it is found that they reduced their operating expenses by $82,648,591, or 10.88 per cent., so as to show a decrease in their net income of only $40,323,603. Taxes, interest on bonds, and operating expenses must be met before dividends are possible. All economies are, in the nature of things, confined to the category of running expenses.

How this can be done, and to what extent it can be carried, is indicated by Mr. Chauncey Depew, who is reported to have made the following statement to an interviewer in reply to the question, 'How is it possible for a railroad to continue paying its dividends in such times as these?' Among other things Mr. Depew said: 'The only way to meet such an emergency is to reduce expenses. When that is said, the question naturally arises: "If you can economize so vastly now, why are not your expenses in good times pure extravagances?"

"'A road that is in first-class condition can run a year or two without spending much for new buildings and equipments. That means that you can discharge from one-fourth to one-third of your entire force of employees, and so cut down the pay-roll. You must stop constructing new tracks, and you must reduce your repairs to a minimum. Unless you have kept your road in first-class condition, you cannot do this; but, if you have, you can practice those economies about two years. It would be very poor economy, unless you had enough faith in the general prosperity of the country to be sure that you could bring the road up again to its normal standard of excellence.

"'The Lake Shore Railroad, now one of the strongest in the country, in 1873 found itself in such a dilapidated condition of roadway, equipment, and stations through this process of neglecting repairs in order to pay dividends in hard times, that, after the return of good times, it was forced to suspend paying dividends in order to raise sufficient money to put the road in shape again. These are painful times for the manager of a railroad, because he wants to get something for his stockholders, if possible, and at the same time he does not want to see the road run down. Especially does it grieve him to see good men out of employment through no fault of their own. There is simply nothing for them to do.'"

Mr. Depew is further quoted as saying that, "if the stringency should last for 4 or 5 years, few roads would be able to pay any but very small dividends." He expressed the view, however, that such a concurrence of financial depression and crop failures as we have passed through in 1894 is unlikely to occur again in a long time. The effect of the hard times upon the workmen employed by the railways is reviewed in our department of Industrial Sociology in the present number. The hard times not only bore hard upon stockholders, directors, and managers, but also fell with crushing force upon the army of railway employees.

Railroads in Default.

IN another place in this department the effect of hard times upon American railroads is considered. In connection with that review an article in *The Banker's Magazine* for April, entitled "Railroads in Default on Their Mortgage Bonds," proves that the railroad interests bore up against the pressure in a most remarkable manner. A statement made in a London newspaper that "about one-third of the railroads in the United States are in default on their bonds" is shown to be a gross exaggeration of actual facts, and an impression, prevalent both in this country and abroad, "that a large proportion of the railroads of the United States have failed to pay interest on their bonds" is erroneous. A careful examination of the subject is asserted to have been made for *The Banker's Magazine*, and it is found that out of 679 railways only 106, or less than one-sixth the whole number, are in default, while out of $5,600,000,000 of outstanding bonds "the amount now in default is $976,000,000, or less than 17½ per cent. of the whole." The roads are grouped, and the amount in default is apportioned to the different groups in the following tabulated statement.

NUMBER OF RAILROADS AND AMOUNT OF BONDS IN DEFAULT.

	Number of Roads.	Amount of Bonds.
New England States	1	$15,000,000
Middle States	8	92.529,400
Middle Western and Western States	32	100,921.290
Southern States	39	129,385,175
Southwestern States	7	29,907,000
Pacific Railroads	17	579,765,000
Pacific States	5	28,515,000
Grand total	109	$976,022,865

"In such times of panic and depression as this country has passed through during the past two years there is an unfortunate tendency to exaggerate evils, and to overstate figures purporting to represent the extent of the troubles, especially in those branches of business where there are no government figures, nor any other statistics kept up with a reasonable degree of accuracy. It may, therefore, be somewhat reassuring to investors to know that only about 18 per cent. of the United States railroad bonds are now failing to yield promptly their interest as it falls due ; and even this overstates the case, for the interest on quite a number of bonds embraced in the table is paid a few months after it becomes due, and the default in each instance is only temporary. Considering the unexampled depression in business and the decline in railroad earnings which has attended the financial crisis of 1893-1895, and particularly the collapse in business since the termination of the Chicago Fair in November, 1893, the question may reasonably be asked why no more railroads have gone to default, and how the companies of moderate financial strength have been able to bridge over the chasm and meet their obligations."

Substantially the same reason is assigned in answer to the question as is given in the article in *The Peterson Magazine.* The railroads were in good condition when the financial storm broke upon the country, and they have since in great measure "been living on their own fat." The *Banker's Magazine*, however, takes a far deeper and more comprehensive view of the "causes which led up to the great railroad disasters of 1893-1894," and inquires whether they are "likely to be repeated."

The following causes are named. "(1) The over-building of railroads, almost entirely out of the proceeds of bonds, in localities where the business in dull times was inadequate to support them. (2) An unreasonable hostility towards railroad capitalists, in some of the western and southern States and also in congress, which led to the passage of laws reducing freight rates and otherwise hampering the companies. (3) The enormous falling off in traffic which followed the silver crisis of 1893, owing to the suspension of banks and the general demoralization of trade. (4) In the case of particular roads, bad management."

Passing some elucidation of the way in which these causes have combined to injure railway business, we notice another cause not included in the above category. "There has unquestionably been too close a connection in the past between stock-exchange speculation and the management of leading railroad properties, and this is largely objectionable. But to those whose memories of Wall street run back for thirty years or more it is possible to see that this speculative tendency of managers has been constantly diminishing, and, as one property after another has reached a dividend-paying basis, the stocks have been taken for investment and removed from the control of speculators. But this gradual process is not sufficient ; there should be a more pronounced public sentiment against all railroad officers who are speculating in the stocks of their respective roads, as it is practically impossible for an executive officer to act with perfect integrity and due regard to the interests of all stockholders, if he is selling and buying and again selling 'short' the stock of his own company. The very notoriety given to the proceedings of McLeod and Reinhart showed that such action on the part of railroad officers was considered a rare thing ; but the revelations in Reading and Atchison had a serious effect abroad, and did much damage in prejudicing investors against American railroad bonds in general. If the real facts could be ascertained, it might be found that the effect of those two developments alone had been sufficient to cause a return of our railroad securities, and a withholding from investment in others, that was equivalent altogether to a balance against us of $25,000,000 or upwards. This subject is closely allied to the matter of gold exports and to the financial history of the past year."

The question raised as to whether the causes of disaster above enumerated are likely to be repeated does not seem conclusively answered, and, probably, if most people had to answer it, they would ask for something easier. It is thought "that the lessons of the past will not be lost," and that "railroad financiering will be conducted more carefully hereafter."

Locomotives with More than Two Cranks.

IN this department (April) we reviewed an article by Mr. Geo. S. Morrison in the *Railroad Gazette* (Feb. 22), wherein the adequacy of hitherto existing methods of balancing was questioned, and the possibility of attaining an accurate balance at highest speeds in four-cylinder locomotives with four cranks, two on each side, each pair set on the quarter from those on the opposite side, was asserted. The argument seemed conclusive that only in this way, or in some other way analogous to it, can be reached a satisfactory locomotive balance for the high speeds now in vogue, and the prospective higher speeds likely to be attempted in the near future.

Mr. Morrison's argument, however, does not seem convincing to *The Railroad Gazette*, which (April 12), editorially criticising an English correspondent's proposition to place cranks 180 deg. apart, and use an auxiliary engine for starting the cranks off from the center, states that "no one has been able to show that the use of two cranks at right angles makes it impossible to prevent injury to the track." But this appears to us just what Mr. Morrison claimed to have been demonstrated by recent investigations. The tracks of railroads, according to this eminent engineer, have suffered under modern high-speed running, and the injury has been directly traced to want of balance in locomotives. And he proceeds to show that "the only method whereby a locomotive can be perfectly counterbalanced is one in which the center of gravity is kept constant under all conditions, both vertically and horizontally."

He further shows that, if the two cranks of a locomotive were placed at an angle of 180° from each other, it would yet be impossible to keep the center of gravity constant, and that only a partial counterbalance could be thus obtained. The 180° angle being, for well-understood practical reasons, out of the question, either for a two- or a three-crank locomotive, and the quarter position being essential, it seems to us that the four-crank system is the only way to a perfect counterbalance, as asserted by Mr. Morrison.

An apology is made for even discussing the English correspondent's scheme, and the perusal of the entire article almost compels the belief that it would not have been noticed except for the opportunity to make the above-stated proposition regarding the alleged inability "to show that the use of two cranks at right angles makes it impossible to prevent injury to the track." The editorial under consideration says further:

"Those who are watching locomotive development know that we shall soon have for trial some four-cylinder, four-crank compounds, not unlike those tried in France. The prime object of these designs will be to do away with the effect of the counterbalances upon the track. They will demand some serious consideration, and it will be well to look ahead a bit and see what advantages they will probably offer, for advantages they must have or they can never meet with the approval of those who repair locomotives, on account of the greater number of wearing parts. The argument that is offered by those who will bring this type forward is that a compound engine is necessary for economy; that a two-cylinder compound is too heavy in its reciprocating parts on one side; and that four-cylinder compounds, with but two cranks, cannot be balanced with safety to the track. This argument has some holes in it, and these will be found, and must be stopped with logic; and—what is more important—facts as to the real condition of the designs of existing compounds must be gathered. First, it must be learned whether the compound locomotive gives any advantage at high speeds, and for this we may wait for the tests that are to be made at Purdue University, on the shop test locomotive. If the compound is not a decided advantage, then the simple two-cylinder locomotive is the best, so far, for high speeds, when it is properly designed."

The writer of the above quotation subsequently expresses the belief that injury to tracks may be avoided by reducing the weights of reciprocating parts,—such as pistons and cross-heads; and doubtless, were wrought-steel pistons substituted for cast-iron ones, and so on, these parts could be made considerably lighter. But, when the principles laid down by Mr. Morrison are carefully considered, we cannot understand how it can be concluded that this change in design would result in anything more than a partial mitigation of track-pounding, while the four-wheel system would be a complete cure.

Competition of Electric Railways.

THE competition of trolley lines with previously-established lines of railway has become a matter of serious consideration for the managers of the old lines. Many of these have experienced a marked reduction of income from loss of what is styled "local suburban traffic," and trolley lines running short distances at frequent intervals between stations have absorbed a kind of traffic which, as long as it could be retained, was obtained without any material increase in cost of running expenses. On the other hand, its loss has not materially decreased expenses. This kind of traffic has, therefore, been an important item in the general business of railways.

The subject is now attracting much attention in railroad circles, and the papers published in the interest of railways are discussing it freely. *The Railway Age* (April 5) speaks of this competition as not only already serious, but prospective. It is likely to increase. "Within a few short months scores of rapidly-constructed and cheaply-run electric roads have been put in operation alongside of steam roads, and by their low fares and frequent service have at once deprived the latter of a large share of the suburban travel which they have been engaged for years, and often at a heavy loss, in building up. With possession of streets and highways given them without charge, and with no expense for grading, bridging, signaling, station building, ticket selling, and numerous other items of cost, the street-railway companies have simply had to lay down their rails and put up their poles and proceed to carry passengers at half or a quarter the rates at which the great roads are able to furnish their more costly accommodations. Every large city in the country is already the scene of this fast-growing competition, but in none has it thus far become so surprising as at Philadelphia. Here the trolley lines are allowed to enter the heart of the city, occupying almost every alternate one of the narrow streets, along which they rush at high speed to and from most of the numerous suburban towns within a distance of from 10 to perhaps 20 miles. The steam roads have instantly felt the effects, in a falling off from 50 to 70 per cent., and at some points even more, of their suburban travel, and this too in the winter, when the greater comfort of the steam cars is most appreciated. In warm weather, when open cars are attractive, the trolley business will naturally increase, as we demonstrated last summer, when 'trolley parties' were the rage on the Philadelphia roads which had then begun to reach the suburbs, and sufficient cars could not be provided to meet the demand. Many hundreds of miles of electric lines have been added throughout the country in the last few months, and thousands of miles more are already projected."

While Philadelphia has been quoted as a conspicuous example of trolley competition, it is by no means single in this respect. The trolley lines running in and out of Boston and New York have had a similar, if not so notable, an effect upon the steam railways. In Brooklyn the elevated roads have found the trolley competition difficult to meet, and, had it not been for the strikes on the trolley lines and the numerous accidents for which the trolley roads of Brooklyn have become famous or infamous, the struggle of the elevated roads to retain their patronage would have been still harder.

The steam lines running in and out of Philadelphia have endeavored to retain as much as possible of this kind of traffic by sweeping reductions of fares and by running more local trains. It is stated that their reduction of fares averages 40 per cent. "In Connecticut the competition has become so troublesome and the danger of level grade crossings by electric roads is so great that the railway companies are demanding that the legislature throw around the new roads some of the same restrictions that the old roads endure. The management of the New York, New Haven & Hartford railroad made a statement showing the loss in the last 3 months by electric competition at various stations, ranging from 40 to as high as 95 per cent. Between Naugatuck and Waterbury (5 miles), for example, the sale of tickets had fallen off 7000 a month. It was urged with evident reason that, if the highways of the State are to be turned over to the electric roads, they should be placed under the same conditions and laws that the steam roads live under."

It is suggested that the steam roads may meet this competition "by putting trolley cars on their own tracks to do the short-distance passenger service," and it is stated that several roads have resolved to try this expedient. Among the roads named that will do this are the Pennsylvania on its Burlington & Mount Holly branch (6 miles), the New York, New Haven & Hartford on its Nantasket Beach branch (7 miles), and the New York Central, it is lately reported, on its Buffalo & Niagara Falls branch (22 miles). The article concludes with the opinion that, with long electric roads coming to the front and the great increase in local trolley lines to be reasonably expected, "the points at which the steam roads will not feel in greater or less degree the presence of this new and aggressive competitor in the next few years are likely to be few and far between."

Chilled Car-Wheels.

An abstract of a paper read before the last annual meeting of the Association of Manufacturers of Chilled Car-Wheels, by Mr. William W. Lobdell, is printed in *The Iron Trade Review* (April 11). Chilled car-wheels are therein stated to be "a distinctively American product," for, although they are to some extent manufactured in Austria and Sweden, millions of these wheels are now turned out of more than one hundred different American establishments, and the industry, involving millions of capital, employs thousands of skilled workmen. Mr. Lobdell thinks some of the particulars of this industry will be new even to many "actively engaged in railroad management."

"When certain kinds of gray cast iron are melted and poured against a metallic mold, that portion of the iron next to the mold becomes hard, white, crystaline, and brittle, while the interior portion remains gray and more or less tough and fibrous. This conversion of the iron that comes in contact with the metallic mold into the hard, white variety is called 'chilling,' and it is upon this principle that the manufacture of chilled car-wheels depends. This property of chilling, which certain irons possess, must have been known to iron-founders at an early day, for we have evidence of the fact that parts of ploughs, faces of forge-hammers, punches for punching holes in wagon-tires, rolls for rolling metal, and various other implements, were chilled long before the manufacture of car-wheels."

Chilled castings and chilled wheels were originally made from charcoal irons, and, as the property of "chilling" is not possessed in a high degree by either coke or anthracite irons, for best results charcoal irons are still indispensable. "The plates and hub of the wheel must be cast in a sand mold, the result being that they are soft enough to be bored or machined, while the tread is so hard that the finest-tempered file will not affect it. What, then, is this peculiar property of chilling? The supposition is that the chemical difference between the chilled portion of a wheel and the plates or hub is simply in the proportion of combined and free or graphitic carbon, that of the chilled part being high in combined carbon, the free or graphitic carbon having been changed to combined by the rapid cooling of the tread by reason of its being cast against a metallic mold technically called a chill."

"This rapid cooling of the tread of the wheel—the metallic mold in which it is cast being a good conductor of heat, whilst the sand mold against which the hub and plates are cast is a poor conductor—causes an undue strain upon the wheel, which must be relieved in some manner, or the wheel would be unfit for service. With the adoption of the form of pattern such as is used to-day came the necessity for some mode of slow cooling and annealing. Probably the first method practised was to take the wheels from the molds in which they were cast as soon as the iron was set, and cover them up in hot sand or ashes, and allow them to remain several days, until nearly cold. Another was to lay them on the floor and build a fire around the tread, so as to bring the temperature of the tread up to that of the hub and plates, and then allow them to cool slowly. To a certain extent both of these methods accomplished the desired results, and were probably sufficient for the requirements of the times in which they were practised. The latest and probably the best plan is to place the wheels, as soon as they can be removed from the molds, in tight pits lined with fire-brick, or some other substance, that will stand the heat,—ten or more in each pit. The wheels are allowed to remain in the pits several days, and are not removed until all tendency to fracture from strain has been removed."

The chilled portion of the tread is harder than any steel that can be used in a tire with safety. Mileages of from 200,000 to 300,000 have been obtained from 30-in. and 33-in. chilled wheels. Excessive heat may neutralize the effect of the chills, and, when brakes are applied to an extent that causes the wheels to slip, their friction on the track may produce heat sufficient to cause "shelled-out" spots. "If the wheel is broken through these shelled-out spots," a violet discoloration distinctly indicates that they are caused by heating. Manufacturers have been blamed in such cases, when the fault was not theirs.

"If the specifications and physical tests formulated by expert mechanical engineers and adopted by some prominent railroads of the country—and which are now much more severe and exacting than those first formulated—can be taken as a maximum required to meet the conditions of the increase in speed and weight of equipment of the present time, then the limit of the strength of cast-iron wheels has not been reached, as they are successfully met by all reputable manufacturers; and, as long as charcoal irons can be produced approximating 35,000 to 40,000 lbs. tensile strength per sq. in., it is not likely that the limit of strength will be exhausted, until the speed and weight of equipment are increased beyond anything now contemplated."

The Return to Single Drive-Wheels.

It is curious to note in the history of inventions the occasional reversion to abandoned types of construction. Many things have been laid on the shelf, not because they were defective in themselves, but because they were found incompatible with then-existing conditions and requirements. General progress along the line of mechanical construction often changes conditions so much that what has been laid aside again becomes useful. The system of coupled drive-wheels was adopted for locomotives to avoid injury to tracks resulting from too heavy a load on single wheels. Steel rails substituted for iron ones have greatly increased the resistant power of the track against the action of wheels, and there are now indications of a return to single driving-wheels. It is true, the single driving-wheels have never gone wholly out of use, but coupled wheels for a considerable period have been the rule, and many have supposed the day of single driving-wheels to be past. On the contrary, *The Railway World* says that "one of the most conspicuous features of the recent development of the English express engine has been the return, by many of the largest lines, to the old system of single driving-wheels. Those companies which have never entirely given them up have lately been building new types of single engines for the fastest express traffic, and at the present time the single engine is more in favor in this country than it has been for the last twenty years."

The causes assigned for the restoration of the single wheel to favor are increased speed, reduction in the number of stoppages, and the longer runs now made; and it is stated that in English practice the "single engine has always done the best main-line work, and it is now capable of doing, on all but a few exceptionally steep lines, practically all that a coupled engine can do."

The writer of the article, Mr. W. B. Paley, thinks that in the United States railroad men cannot be expected to appreciate "the merits of single engines, as they have practically no experience with them; but it is certain that the long runs and high speeds of trains like the Empire State expresses of the New York Central Railroad must be extremely trying to coupled engines, whatever may be the size of their driving-wheels." The reason for the adoption of the four-coupled express engine in England "was not so much because it was liked, as because the weight of the trains required more adhesion than could, with iron rails, be advantageously placed upon a single pair of wheels. The conveyance of third-class passengers by all trains gave an immense impulse to traveling, and, had not this coincided pretty closely with the discovery of how to make steel rails cheaply and well, it is nearly certain that the single engine would now be a thing of the past. To Mr. Patrick Sterling, locomotive engineer of the Northern Railway, is due the credit of having first foreseen the advantages and possibilities of the new rails. His 8-ft. single engines, with leading bogie, were designed about 1869, and the unusual load of 15 tons on the driving-wheels proved well within the endurance of the steel rails with which the Great Northern main line was even then partly laid. Although the third-class movement did not begin till 3 years after these engines were designed,—and it practically doubled the weight of the trains at once,—they are still able to cope with the heaviest traffic upon what has always been the fastest line in the kingdom. Except that the weight on the drivers has been increased to 17 tons, both in the old and the new engines, the design remains practically the same as it was 26 years ago. A few details of these splendid engines may be acceptable."

Diameter of bogie wheels, 3 ft. 10 in.; diameter of driving-wheels, 8 ft.; diameter of trailing wheels, 4 ft. 6 in.; number of tubes (copper), 174; diameter of tubes, 1¾ in.; largest diameter of boiler, 4 ft. 2 in.; length of boiler, 11 ft. 5 in.; diameter of cylinder, 18 in.; stroke 28.; heating surface of tubes, 936 sq. ft.; heating surface of fire-box, 109 sq. ft.; total heating surface, 1045 sq. ft.; grate area, 17 ¾ sq. ft.; weight on bogie, 17 tons; weight on trailers, 10 tons, 12 cwt.; total weight (full), 45 tons, 3 cwt.

Since the article was written, Mr. Sterling has designed six engines of this class, but more powerful than the one described. The bogie and driving-wheels are of the size named, but the cylinders have a diameter of 19 ¼ in. and 28 in. stroke. The steam pressure carried will be 175 lbs., and the engine and tender together weigh 90 tons.

Electrical Car-Heating.

The Railroad Gazette (March 22) editorially enters into a comparison of the cost of electrical car-heating as compared with steam heating. All the items which enter into the cost of both systems, as interest on cost of apparatus, cost of repairs and attendance, and cost of fuel in the one case, and cost of power for generating the electric current in the other, are carefully considered, and the conclusion is reached that, while steam heating costs per car-hour 3.75 cts., when coal is $4.50 per ton, heating by electricity costs 10.7 cts. per car-hour, when the price of coal is the same, or a little more than three times as much as steam heating. An effort to be perfectly fair to electric heating is apparent in this article, and in some items, we think our contemporary has been more than fair.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

30876. The Block System on the Chicago, Milwaukee and St. Paul. C. A. Goodnow (R R Gaz–April 12.) 1800 w.

30877. New York Central Track Elevation on Park Avenue. Ill. (R R Gaz–April 12.) 2000 w.

30880. The Webb and Thompson Train Staff System ; C. M. & St. P. R'y. Ill. (Eng News–April 11.) 2500 w.

30885. Chicago City Railway Company Wrecks a Rival Company's Car. Ill. (W. Elec–April 13.) 1800 w.

*30924. The Revival of the "Single" Engine. Ill. W. B. Paley (*Ry Wrld*-April.) 1800 w.

30970. The Lenox Avenue Electric Conduit System of the Metropolitan Traction Company. Ill. (St Ry Gaz–April 13.) 2000 w.

30979. Cast Iron Chilled Car Wheels. William W. Lobdell (Ir Tr Rev–April 11.) 1800 w.

31051. Rebuilding Railway Works Without Stopping Traffic. Ill. (Eng News–April 18.) 800 w.

*31052. The Kuhlman Counterweight System at Providence. Ill. (St Ry Rev–April.) 900 w.

*31053. Rules and Discipline of Street Railways. H. S. Cooper (St Ry Rev–April.) 2800 w.

*31055. Steam Street Railways in Italy (St Ry Rev–April.) 1000 w.

*31056. Another "Home Made" Snow Plow. Ill. I. B. Walker (St Ry Rev–April.) 650 w.

*31057. War Against Connecticut Electric Roads (St Ry Rev–April) 4000 w.

31068. Hollerith's Electric Tabulating Machine. Ill. (R R Gaz–April 19.) 4400 w.

31069. Reorganization of Atchison. Editorial (R R Gaz–April 19.) 1800 w.

31070. A Case of Narrow Gauge. Editorial (R R Gaz–April 19.) 1600 w.

31071. The Permissable Strain on Draft Rigging. Editorial (R R Gaz–April 19.) 1300 w.

*31120. American Electrical Tramway Gearing. Ill. J. D. Dallas (*Elect'n*–April 12.) 1600 w.

*31131. The Transport of Fish by Rail (*Trans*–April 12.) 1200 w.

31142. The Electric Railway for Interurban Traffic. Ralph W. Pope (St Ry Gaz–April 20.) 2200 w.

*31145. Some Methods of Collecting the Energy in Electric Railways and Tramways. Holroyd Smith (*Elec Eng*–April 12.) 3500 w.

*31157. Railroad Signaling. Charles S. Churchill, with Discussion (Jour Asso Eng Soc–March.) 10400 w.

31159. Single Track Blocking on the Chicago, Milwaukee and St. Paul. C. A. Goodnow (Ry Rev–April 20.) 1800 w.

31160. Spring Rail Frogs. Ill. (Ry Rev–April 20.) 1300 w.

31161. Grade Crossings.—Bill Proposed by the Railroad Commission of the State of New York (Ry Rev–April 20.) 1800 w.

31162. The Relations of Railroad Men to Each Other and to the Public. George H. Daniels (Ry Rev–April 20.) 1200 w.

31163. Locomotive Smoke Stacks. Ill. Herbert M. Ramp (Foundry–April.) 1400 w.

*31181. Will the Electric Motor Supersede the Steam Locomotive. Joseph Wetzler (Scrib Mag–May.) 3300 w.

31191. The West Side Metropolitan Elevated Railway System of Chicago. Ill. (Sci Amer–April 27.) 1500 w.

31202. Shall a Street Railway Company Be Allowed to Use the Existing Tracks of a Competitor? Complaint at Chicago (W Elec–April 27.) 3000 w.

31207. The Physical Characteristics of the Lake Erie and Western Railroad (Eng News–April 25) 1500 w.

31209. Locomotives with More Than Two Cranks. Editorial (R R Gaz–April 26.) 1200 w.

31210. The Railroads of China. Editorial (R R Gaz–April 26.) 1800 w.

31214. Gas Motor Street Car Line in Dessau, Germany. Ill. Extract from the Jour. fuer Gasbeleuchtung (Safety V–April 15.) 600 w.

31218. Hard Times and the Railroads. Ill. A Staff Writer (Peterson Mag–May.) 3800 w.

31219. The American Locomotive. Ill. Charles W. Strine (Peterson Mag–May.) 6800 w.

†31235. Our Railroads in Default on Their Mortgage Bonds.—109 Roads, $976,022,865 Bonds (Bank Mag–April.) 2800 w.

*31251. The Great Dock Fight.—London vs. Southampton (*Fairplay*–April 19) 900 w.

*31254. The Rating of Railways.—Antiquated Methods (*Ry Times*–April 20.) 1800 w.

31265. Car Service Rules Coldly Considered. Observer (Ry Rev–April 27.) 1000 w.

31266. Track Elevation in Chicago.—Chicago and Northwestern Railway. Ill. (Ry Rev–April 27.) 2000 w.

31267. Timbering in the Ampthill Second Tunnel. Ill. Edward Ewing Matheson. Read before Inst. of Civ. Eng. (Ry Rev–April 27.) 2000 w.

*31271. The Grand Trunk Indictment (*Trans*–April 19) 1100 w.

31292. The Atchison Reorganization Plan. Editorial (Ry Age–April 26.) 1100 w.

*31296. The Railway Rates Decision. Editorial (*Engng*–April 19.) 1700 w.

31301. Great Railway Systems of the United States. Ill. J. B. Walker (Cos–May.) 3600 w.

*31339. English and American Railway Development. Editorial (*Ir & Coal Tr Rev*–April 19.) 1400 w.

*31347. Electric Traction. I. William Chubb (*Prac Eng*–April 19.) 2200 w.

†31350. The Madras Railway. Editorial (*Ind Engng*–March 23.) 1000 w.

*31361. The Need of a Change in Car Inspection. S. A. Charpiot (Loc Engng–May.) 700 w.

*31363. Standard Air Brake Freight Levers. B. Haskell (Loc Engng–May.) 1800 w.

*31364. Smoke Prevention. Editorial (Loc Engng–May.) 1600 w.

*31377. Locomotive Performances on Southern Pacific Railroad (Nat Car Build–May.) 1200 w.

31388. The Proposed Railway up the Jungfrau. Ill. (Sci Amer–May 4) 600 w.

*31400. The Use of Gas Engines for Tramways (*Jour Gas Lgt*–April 23) 1800 w.

*31419. Sand-Shed at Hornellsville, New York, Lake Erie and Western Railroad. Ill. (Am Eng & R R Jour–May.) 1000 w.

*31421. The Great Siberian Railroad. Ill. (Am Eng and R R Jour–May.) 1600 w.

31431. Fast Run from Camden to Atlantic City, with Editorial (R R Gaz-May 3.) 1200 w.

31432. Freight Rates from Denver to San Francisco. Editorial (R R Gaz–May 3.) 1300 w.

31433. Rates for American Produce between Southampton and London. Editorial(R R Gaz–May 3) 1600 w.

†31435. The Street Railway System of Hartford, Conn. Ill. (St Ry Jour–May.) 4000 w.

†31438. The Function of a Reserve Fund in Street Railway Operation. Edward E. Higgins (St Ry Jour–May.) 3500 w.

31462. The Publication of Engine Men's Records on the Chesapeake and Ohio Railroad (Ry Eng & Mech–May.) 1000 w.

31463. Railways Do Not Always Get What They Buy.—Safeguards Suggested. Experience (Ry Eng & Mech–May.) 1000 w.

†31481. Efficiency Tests of the Urbana and Champaign Electric Street Railway. Ill. C. H. Trego and O. E. Goldschmidt (Tech–No. 9.) 6500 w.

†31482. Railroad Crossing Frogs. William D. Pence (Tech–No. 9.) 3000 w.

†31494. Investigation and Experiments for the Determination of the Groove in Guard Rails for Street Railways. Ill. V. Angerer (Pro Eng Club of Phila–April.) 4500 w.

†31496. Topical Discussion.—The Promotion and Improvement of Rapid Transit in Philadelphia (Pro Eng Club of Phila–April.) 4000 w.

*31513. The Gaisberg Rack Railway. Ill. (*Eng*–April 26.) 1200 w.

31545. Electric Railways as Freight Carriers. Editorial (Ry Age–May 3.) 800 w.

31546. Merchants Combine to "Boycott" Railways. Dallas—Tex.) (Ry Age–May 3.) 800 w.

31548. Locomotive Tools.—Discussion of New York Railroad Club. (Abstract.) (Ry Age–May 3.) 2000 w.

†31571. A Partial Solution of the Railway Problem. C. J. Buell (Arena-May.) 600 w.

31578. Prevention of Electrolysis by Trolley Currents. W. Stuart-Smith (Elec Wrld–May 11.) 1700 w.

31591. Extension of the Paris-Sceaux Railway. Ill. (Sci Am Sup–May 11.) 1100 w.

31605. An Instruction Car for Trainmen.—C. N. O. & T. Railroad. Ill. (R R Gaz–May 10.)1300 w.

31606. Duty of Railroads to Ice Perishable Freights. Editorial (R R Gaz–May 10.) 1300 w.

31607. The Anthracite Situation. Editorial (R R Gaz–May 10.) 700 w.

31608. Twelve-Wheel Freight Locomotives, Southern Pacific Railway. Ill. (Eng News–May 9.) 1200 w.

Serials.

17826. Evolution of the Air Brake. Ill. Paul Synnestvedt (Ry Eng & Mech–Began Dec., 1893—15 parts to date—15 cts. each).

24586. Railway Companies and Their Employes. O. D. Ashley (Ry Age–Began Aug. 24, 1894—11 parts to date—15 cts. each).

28138. Block Signaling. Ill. W. H. Elliot (Loc Engng—Began Jan.–5 parts to date—30 cts. each).

28496. Electric Traction. Ill. Philip Dawson (*Engng*–Began Jan. 4—15 parts to date—30 cts. each).

28897. Motor Repairs. Ill. W. E. Shepard (St Ry Jour–Began Feb.—4 parts to date—45 cts. each).

29369. Tramway Management. By a Manager (*Ry Wrld*–Began Feb.—3 parts to date—30 cts. each).

29384. Street Railway Wheel Threads and Flanges.—Is a Standard Desirable? (St Ry Rev–Began Feb.—3 parts to date—30 cts. each).

29775. Yard Arrangements Along Heavy-Traffic High-Speed Railroads. A. Flamanche (Am Eng & Rail Jour–Began March—Ended May—3 parts—30 cts. each).

30158. Notes on Some French and Swiss Railways (*Ry Wrld*–Began March—2 parts to date—30 cts. each).

30604. Locomotive Repair Shop Equipment. W. H. Weston (Nat Car Build–Began April—2 parts to date—30 cts. each).

30654. Electric Railway Repair Shops. H. P. Merriam (St Ry Jour–Began April—2 parts to date—45 cts. each).

30668. The People's Highways. Frank Parsons (Arena–Began April—Ended May—2 parts—45 cts. each).

30787. Light Railways in Belgium. Ill. (*Eng*–Began March 29—3 parts to date—30 cts. each).

31067. The Railroad Situation in California. Ill. By a Citizen of California (R R Gaz–Began April 19—Ended April 26—2 parts—15 cts. each).

31147. Mountain Climbing Railways. Ernest Scott (*Elec Eng*–Began April 12—2 parts to date—30 cts. each).

31158. Per Diem and Car Movements. W. E. Beecham (Ry Rev–Began April 20—Ended April 27—2 parts—30 cts. each).

31211. The Stresses in Car Axles (R R Gaz–Began April 26—2 parts to date—15 cts. each).

31264. The Railway Situation. Address of H. S. Haines, with Editorial (Ry Rev–Began April 27—1 part to date—15 cts).

31293. State Railways in Western Sumatra. Ill. (*Engng*–Began April 19—1 part to date—30 cts).

SCIENTIFIC MISCELLANY

Central American Rainfall.

A PAPER read before the Philosophical Society of Washington (March 2) by Mark Walford Harrington, and published in pamphlet form (*Bulletin*, Vol. III), not only contains a very exhaustive discussion of rainfall in Central America, but also presents many interesting facts relating generally to tropical rainfall. Tabulated results of observations are profusely given, and plates help to elucidate the subject. Some of the facts presented will be new to many readers.

"From Darien to Yucatan stretches a narrow, irregular land surface, washed on each side by a tropical sea. It extends through 10 degrees of latitude (8° north to 18° north), and is 1200 miles long by from 30 to 300 miles broad. It has an average width of 150 miles and a population of 18 per square mile,—a density closely equal to that of the United States as a whole, including Alaska, or that of Minnesota or Kansas. Through the center of this band runs a backbone of mountains, generally less than 10,000 ft. high, and for fully half of the distance less than 6000 ft., sometimes descending to moderate hills, at others expanding fan-shaped to form extensive plateaus of 3000 ft. or more. The coasts are rarely high, and along a considerable part of them is an area little above the sea level, marked by lagoons and floods. Generally this strip is narrow, but along the Mosquito Coast for a distance of 300 miles it has a breadth of 100 to 150 miles. The western versant is more rapid than the eastern."

"The rainfall in this region is typically tropical and follows the sun, giving a dry season when the sun is south of the equator and a wet season when he is north, and giving a maximum rainfall in or near the month when he is the zenith of the station of observation. This means two maxima per year; so that there are two rainy seasons, with a long and a short interval between them. The long dry season is in the months corresponding to our winter and spring, and is called the *verano.* It extends from December to April. The wet season is from May to November, and is called the *invierno,* while the short, drier season is in August, and is called the *veranillo* or little *verano*, also *verano de Augosto.*"

Terms adopted by Mr. Harrington for indicating peculiarities of season are *verano* (long dry), *invierno* (wet), and *veranillo* (short dry). "Beginning with the height of the *verano*, in April, the weather is serene, clear, and the hottest of the year. On the plateaus it is delightful. With May or June the rainy season (*invierno*) sets in. It is due to local storms, with a striking diurnal course. The morning is cool and fresh. In the later hours of the forenoon cumulus clouds begin to appear about the mountain peaks, and are specially picturesque when hanging about volcanoes. They steadily grow and spread until cirrus streaks begin to extend from their tops, their bases become dark and threatening, and finally, late in the afternoon, the lightning flashes brilliantly, the thunder is loud and startling in its suddenness, and cataracts of water fall from the clouds. This lasts but a short time, and before one retires at night the sky is again clear and the stars remarkably brilliant. These thunderstorm phenomena gradually increase in daily duration and intensity, extending especially into the night, until the time of maximum rainfall in June. At that time it may begin to rain early in the afternoon and continue all night. The thunderstorms then decrease to the *veranillo*, at which time they may cease entirely for a few days or weeks. They begin again after it, and reach a second maximum in October, when they gradually decrease until December. The rainfall phenomena, though short and intense, are very local in area and have marked limitations in time. Their intensity is largely a question of topography and wind. Hence the most marked and striking variations exist, similar to those of local storms elsewhere, but more marked in character. Hence also marked localization of rainfall. A few rods will sometimes make one pass from within a torrential rain to a spot without rain. Hence also remarkable variations in the rainfall from year to year, or in the same month of successive years, or in the monthly rainfall at adjacent stations."

A remarkable periodicity in the amount of a rainfall is apparent from observations made from 1856 to 1893. The maximum rainfalls have occurred in 1856, 1861, 1866-7, 1872, 1878-9, 1886-7, and 1893; from which it appears that these periods of maximum have an interval not far from 5 years on the average, although two of the intervals noted were respectively 6½ and 8 years. The greatest annual rainfall is at Greytown, where it reaches the enormous total of over 20 ft.,—a figure surpassed in America only on the Gulf coast, in the West Indies, Guiana, and on the coast of Brazil. The next greatest rainfall is in Alta Verapaz, and the smallest is along the upper plateaus in most of Central America proper, but more toward the southern coast in the Isthmus region. The maximum rainfall is not near the sea level, but at an elevation of about 2500 ft.

The great violence of some of the rain storms is shown by the fact that from 7 to 10 per cent. of the annual fall has been observed to descend in a single day. "The results of such enormous falls of rain have often been described, and can easily be imagined. The dry stream-beds or quebradas, very common on the plateaus, are rapidly filled; the water comes down in a wall several feet high; the camping place, hastily sought in the dark, and several feet higher, is also overflowed. In such a country as Mosquitia dry stream-beds become rivers, marshes change to lakes, and the natives temporarily take to the trees or to their boats." Such rains are, however, not without parallel in temperate regions; "7.5 in. in a day is no great rarity in the United States, while the Gulf and Atlantic coasts are subject to occasional falls of 10 in. in one day, and Boise, Idaho, once reported 18 in." In a footnote it is stated that probably the greatest rainfalls ever recorded are described in *Nature*, Vol. xlviii, pp. 3 and 77. One of these was at Crohamhurst, Queensland, Australia, where in 1893 there fell 35.7 inches in 24 hours. On June 14, 1876, in Chirapunji, British India, 40.8 inches in one day were reported by Mr. E. Douglas Archibald.

"These conditions are especially interesting from the standpoint of the possible ship-canals in Central America. Though the information is scanty, it appears to have been such a rainfall in 1887 which began the disasters of the Panama canal. It must be acknowledged that the conditions at Suez, Sault Ste. Marie, and the Welland canal are in this respect very favorable, for with them the question of sudden floods does not enter. It enters in the case of the great ship-canal of St. Petersburg-Cronstadt and of those of the Ganges-Brahmaputra delta, but in these cases there are no changes of level sufficient to make the use of locks necessary. Indeed, the use of locks on ship-canals whose feeders are subject to sudden and violent floods appears to present a new engineering problem, first met in the Panama canal."

Manufacture and Uses of Pulverized Charcoal.

To many the statements that the manufacture of pulverized wood charcoal is an organized industry, and that this material has important industrial uses, will be new. The use of bone-black (the charcoal of bones) in refining sugar and other materials has long been practised, and is well known to most well-informed people, but that wood-charcoal has analogous industrial applications of sufficient importance to require its systematic production on a commercial scale is probably not so widely known.

Carbon in the form of charcoal, whether made from bones or wood, is a powerful absorbent of substances which in many refining processes constitute the impurities it is desired to remove. Bone-black is preëminently an absorbent of gases, water, and certain coloring principles. If good, freshly-calcined bone-black be exposed to air, it will absorb many times its own volume of the gases present in the atmosphere. Its attraction for water is, however, so much greater than its attraction for gases that, if, after standing in air for some time, it be covered with water, the water will expel the gases which escape with such activity through the supervening water as to give the latter the appearance of boiling; and this agitation of the water will continue till the gases have all been displaced. When bone-black is exposed to heat in a vessel or retort having an opening for the escape of the absorbed gases, the latter are also expelled, and the material is thus again fitted to act as an absorbent. It is thus that bone-black is renovated in sugar-refineries where it is used over and over again; but in this case the materials expelled in the renovating process are water and the impurities it has extracted from the syrups before the latter have been concentrated to the point of saturation. Wood charcoal has the same properties in a less degree, and it is used for purifying water, wines, glycerine, and other liquid substances. *Scientific American* (April 13) devotes a page to an illustrated description of the manufacture of pulverized wood-charcoal.

The lump charcoal "is bought by the car-load by the manufacturer, who first extracts the gas from the coal by reburning it in kilns, after which the material is passed through a cracking, softening, and grinding process, which produces any grade of charcoal, ranging from flour to pieces as large as peas. The kilns are made of ½-in. boiler-plate iron. They are about 10 ft. in height and about 6½ ft. in diameter inside, and are lined on the interior with fire-brick. Each kiln is pierced with about eighteen draught holes 4 in. in length and about 3 in. in height. A wood fire is started in the bottom of the kiln, and about two or three barrels or bags of lump charcoal placed on it. As soon as the coal becomes red-hot, a little more of the material is added, the operation being continued until the heated charcoal reaches up above the draught hole. The door of the kiln is then plastered up, the stopping of the draught below preventing the charcoal on the bottom from going to ashes and also causing it to gradually cool and retain the same form as before burning. As fast as the fire ascends through the charcoal, fresh layers are thrown into the kiln from the top by the attendants, the draught holes being stopped up with plaster as fast as the material becomes red-hot above each opening. The kiln holds about 70 barrels of charcoal. The top of the kiln is bricked over, with the exception of a circular opening about 2½ ft. in diameter in the center. After burning for about 12 hours, a circular piece of sheet iron is placed over the opening, which smothers the fire, the gas escaping by means of a small hole in the center of the plate."

This part of the process occupies about 48 hours,—from the time of firing up till the material can be cooled off and discharged from the bottom of the kiln. The coal is then cracked in a machine called the "cracker," whence it is passed to a grinding mill consisting of a runner stone revolving over a bed stone, almost exactly modelled after the old-fashioned grain mill. The ground material is screened, and the coarser particles thus separated are returned to the mill to be reground. Another kind of mill for grinding, used for some grades of the product, is a revolving iron cylinder containing iron balls which pulverize the material by rolling upon it. One firm in New York, engaged in this manufacture, is stated to make an output of about half a ton per hour, which is packed in bags holding about 78 lbs. each, this being the form in which it enters into industrial commerce.

Carbon Dioxid as a Refrigerant.

PREMISING that ammonia is not well adapted to refrigeration from central stations, except for small districts, and that its elements of failure are (1) the recovery of the expanded ammonia through return pipes which are far more expensive than the supply pipes, and (2) the difficulty of equitably metering the supply, M. E. F. Osborne contributes to *The Journal of the Association of Engineering Societies* a scheme for central-station refrigeration with carbon dioxid. This gas, after being liquefied under great pressure, in regaining the gaseous condition absorbs heat from surrounding objects, and its latent heat of vaporization is large enough to render it exceedingly effective as a refrigerant. When released from pressure and unable to get heat from other bodies, a portion of it volatilizes at the expense of the heat in the mass, the temperature of which thus falls rapidly enough to freeze what is left after the evaporation. This frozen material thereafter slowly liquefies, and then vaporizes by extracting from warmer contiguous bodies the heat necessary to change it successively into a liquid and gas. It is claimed that it can be made so cheaply that it is not worth while to attempt its recovery or to use it more than once, provided it be made in large quantities by a special process, in a plant properly designed for the purpose.

Carbon dioxid is also one of the most efficient means of extinguishing fires. Its utilization for putting out fires in buildings would entail only a trifling cost in connection with its employment as a refrigerant. It has long been used in portable fire extinguishers, but not in the liquid form. The liquid can only be maintained as such by subjecting it to very great pressure, and in this fact will be found, we think, the origin of many and serious practical difficulties in carrying out Mr. Osborne's proposed scheme. However, the resources of engineering in the management and retention of liquids and gases under high pressure have been greatly enlarged within a few years, and it is by no means impossible that pipes, valves, and fittings can be supplied that will meet the requirements of the system. We quote a description of the plant and process.

"The system consists of a central station provided with one or more gas-producers, calcining retorts, distilling apparatus, boilers, engines, pumps, compressors, and incidental apparatus. The raw materials required are soft coal and limestone. The products are carbon dioxid, commercial lime, carbonate of ammonia, and coal tar. The coal is supplied to retorts, and subjected to destructive distillation, in nearly the same manner as in ordinary gas works, the tar and ammoniacal liquor being separated, the former being sold in that state, and the latter distilled and converted into carbonate of ammonia, packed, and sold. The coke is converted into a semi-water gas, which is used to calcine the limestone. The lime produced is of the best quality, and is sold on the open market either in bulk or by the barrel. The dioxid is purified, cooled, compressed, and liquefied in the same way as is done in ordinary manufactories where this substance is produced for commercial purposes. The liquid dioxid then passes by its own pressure into the main distributing pipes in the street. At the curbstone is a service cock; just inside of the consumer's premises is an automatic valve, which cuts off the supply in case of a break or careless management of the apparatus on the consumer's premises; if the break is permanent, or anything has happened equal to a rupture of the service pipe, the supply remains substantially shut off. When the damage is repaired and normal conditions are established, the supply is automatically turned on. From this valve the dioxid passes to a meter, thence to the automatic regulating valve in the refrigerator, which is set to maintain any temperature desired, from which valve the dioxid is conducted into the cooling chamber or coil located in the space to be cooled. Thereafter the dioxid in gaseous form may be used to charge drinking water, ale, beer, or wine, and for forcing these other liquids from a lower or higher level, as from the basement of stores and restaurants to any floor above; or the gas can be used for preservation of nearly all kinds of food products, where a low temperature is not necessary, especially for fruits, vegetables, and meats. It can also be used for small powers, and the heat that is extracted from the substances cooled goes a long way towards furnishing the motive power required in connection therewith.

"Briefly, the services above referred to are to be furnished from a central station, somewhat similar to a gas or water-works plant, and the carbon dioxid, after its production, delivered into flasks or cylinders for use on board cars, ships, or at other places not directly connected with the central station. Or the dioxid is delivered into a ramification of pipes leading to the premises of the various consumers, where it is metered, automatically regulated, and the resulting gas allowed to go to waste.

"One ton of good soft coal and 3½ tons of limestone will produce rather more than 3,500 lbs. of lime, 3,000 lbs. of carbon dioxid, 6 to 7 gallons of coal tar, and 40 lbs. of carbonate of ammonia."

The Artificial Spectrum Top.

A SCIENTIFIC toy has lately attracted considerable attention in England, and will, doubtless, ere long make its appearance in America, if, indeed, it has not already arrived. A top in which the motion of white and black spots or tracings produces a succession of spectrum colors is, to say the least, a scientific puzzle, and it may be that it sets a problem well worthy of a scientific solution. A plausible theory of this curious effect is given in *Engineering* (April 19) by Mr. Charles Benham, who was the first to set the subject conspicuously before the public eye by placing such tops on the market through a London firm.

The origin of this toy, which may soon take rank among apparatus in physical laboratories, was in a remarkable invention of Mr. Benjamin W. Betts, formerly of Auckland, New Zealand. Mr. Benham says of Mr. Betts that he is a man "of somewhat remarkable philosophy, in which are strangely mingled science, astrology, and a species of mysticism. He has worked out a very singular theory as to flower forms and the geometrical laws which govern them. In carrying out his investigations he was led to expect that by rotary motion his geometrical diagrams ought to show the coloring of leaves and flowers, and in experimenting with this end in view he actually realized his expectations, and found that the cardboard discs which he employed,—discs of various shapes with mysterious slits and loppings in accord with his strange Fichtean doctrines,—when set revolving against a dark background, gave distinct coloring effects. I was much astonished at the instrument, and set to work with my compound pendulum curves to see if they could be adapted to the principle of the chromoscope. I soon found that they could, and I followed up these experiments with innumerable others, with a view to solve the mystery, if possible. After trying every imaginable variation of form and arrangement, I at last hit upon the simple idea of a top with eccentric lines of black on a disc half black and half white. The effect was better than Betts's chromoscope, and the form of the disc I found to be more effective than any other I was able to devise. As, however, I am still frequently being asked whether I have ever tried such and such modifications,—white lines on black, shorter lines, thicker lines, colored lines, &c.,—I may take this opportunity of saying that I think there can hardly be any arrangement of this sort that I have not tested carefully."

One Mr. Jewsberry is said to have made a very similar discovery some years ago, but he did not carry it to a conclusion, and Mr. Benham claims that there is no connection between Mr. Jewsberry's experiments and his own. The top, as now constructed, "consists of a revolving disc, half black and half white. On the white half are short concentric arcs of black. When the top revolves close under a bright lamp, these arcs appear, not as grey lines, as might be expected, but as lines of color. To most eyes the effect is as follows:

"(1) when the revolution is such that the black line is preceded by the black half of the disc and followed by the remainder of the white, it appears red; (2) when the direction of rotation is reversed, it appears blue; (3) when the lines are on the central portion of the white (so as to have equal white immediately on each side), the color is green; (4) intermediate positions give approximately the intermediate colors of the spectrum. A few people see the colors differently, and one or two people, by no means color-blind, can see no color at all. Curiously enough, I know of two people who are somewhat color-blind, but can see the colors on the top very well."

The explanation given by Mr. Jewsberry

is accepted by Mr. Benham,—to wit, that these color effects are purely subjective and physiological. "There is no difference of actinic power in the bands involved in the red way or the blue way. Further, with a bright sodium flame, though practically monochromatic, the colors are very distinct." The hypothesis is that the rapid alternation of white and black lines sets up in the retina the same vibrations as the actual colors do, and that thus the color sensations are produced. Mr. Benham acknowledges that this is only a clue, and thst it does not completely solve the mystery.

Mars a Disappointment.

It is feared that we shall have to abandon all our ideas of the planet Mars that have hitherto made such pleasant food for the imagination, and have furnished so many sensational items for the newspapers, Profs. Campbell, Schaeberle, Barnard, and Holden have been pointing their telescopes at this ruddy orb during the whole period of its opposition, with results that dispel all dreams that it is inhabited. According to Prof. E. C. Holden in the *North American Review* for May, there is no atmosphere to speak of, and no water, on the surface of Mars, and it is therefore inferentially as barren of life as that of the moon is inferred to be from its telescopic aspect. Says Prof. Holden: "The moon has no atmosphere, or, at all events, an indefinitely thin atmosphere. If, then, we compare the spectrum of Mars and the moon (under proper conditions as to altitude, etc.), and if we find them unlike, the unlikeness is due to the absorption of a Martian atmosphere. If, on the other hand, we find them like, then Mars has no atmosphere, just as the moon has none. Such is the principle of the method which Professor Campbell. has carried out at the Lick Observatory during the past summer, taking every precaution to exclude all sources of error. He was unable to detect any difference between the spectrum of Mars and that of the moon under like conditions. That is, Mars has no more atmosphere than the moon, so far as this method is sufficient to detect one. There is no more evidence of aqueous vapor in the atmosphere of Mars than in the no-atmosphere of the moon. The method employed is delicate, but it is not perfectly and absolutely so. An atmosphere one-fourth as extensive as our own would certainly have been detected, and very probably an atmosphere much less extensive than this. The atmosphere of Mars, if indeed it has any at all, must be at least as thin as, probably very much thinner than, that of the highest peaks of the Himalayas."

Now this statement involves the absence of many other things that have been popularly believed in,—"the lakes, oceans, canals (of water), the snow-storms, inundations, inhabitants (like ourselves), and the signals they were making us, etc., etc.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

†30842. Central American Rainfall. Ill. Mark Walrod Harrington (Philosophical Soc of Washington–March 2) 6500 w.

30871. The Future of Fertilizers. A. D. Ledoux (Mfrs Rec–April 12.) 900 w.

30873. A Plea for a Science. W. S. Crosby (Elec Engng–April.) 3500 w.

30888. The Educational and Industrial Value of Science. Henry S. Carhart (Sci–April 12.) 5000 w.

30901. The Pulverized Charcoal Industry. Ill. (Sci Amer–April 13.) 800 w.

*30942. The Age of the Earth. W. J. Sollas (*Nature*–April 4.) 1200 w.

*30043. Professor Mendeléeff on Argon (*Nature*–April 4.) 1000 w.

*30944. Precious Stones, and How to Distinguish Them. H. A. Miers (*Nature*-April 4.) 4500 w.

30986. What is Glass? R. Helmbacher (Am Man & Ir Wld–April 12.) 500 w.

†30990. A New Law of Geographical Dispersal. Charles Dixon (*Fort Rev*–April.) 9300 w.

31041. The Advantages of the South in Cotton.—Opinions of Edward Atkinson (Tradesman–April 15.) 3300 w.

31077. Argon. Experiments of M. Berthelot (Sci–April 19) 700 w.

*31119. Professor Baldwin Brown on the Arts and Crafts (*Brit Arch*–April 12.) 1200 w.

*31173. Carbon Dioxide for Refrigeration and for Extinguishing Fires. (Extract). E. F. Osborne (Jour Asso Eng Soc–March.) 1600 w.

*31177. The Dimensions of the Universe. Garrett P. Serviss (Chau–May.) 3500 w.

31220.—$1. Korea and the Koreans. In the Mirror of their Language and History. William Elliot Griffis (Bul Geog Soc–Vol XXVII, No. 1.) 9000 w.

31221. The Fine Art Confederation. Editorial (Arch & Bldg–April 27.) 1100 w.

*31253. My Recent Voyages in Siberia. Captain Wiggins, with Discussion (*Jour Soc of Arts*–April 19.) 7000 w.

*31263. Australasian Timbers. From "The Year Book of Australia" for 1894 (*Brit Arch*–April 19.) 1100 w.

†31275. The Progress of Meteorology. Frank Waldo (N Amer Rev–May.) 3300 w.

†31277. The Latest News of Mars. Edward S. Holden (N Amer Rev–May.) 1300 w.

*31279. Mechanical Equivalent of Light. A. F. Ravenshear (*Elec Rev*–April 19) 1100 w.

*31299. The Artificial Spectrum Top. Charles Benham (*Engng*–April 19.) 1300 w.

†31302. Archæology in Denmark. Ill. Frederick Starr (Pop Sci M–May.) 3500 w.

†31303. The Work of the Naturalist in the World. Charles Sedgwick Minot (Pop Sci M–May) 6500 w.

*31308. The Free Public Library. H. H. Barber (Am Mag of Civ–May.) 6000 w.

*31311. The Growth of Peace Principles, and the Methods of Propagating Them. Belva A. Lockwood (Am Mag of Civ–May.) 5000 w.

*31312. Distinctive American Citizenship. Adolph Roeder (Am Mag of Civ–May.) 2800 w.

*31314. State Rights and Federal Encroachments. James S. Fisher (Am Mag of Civ–May.) 4000 w.

†31321. James Dwight Dana. Ill. E. S. D. (Am Jour of Sci–May.) 8500 w.

†31322. On the Color Relations of Atoms, Ions and Molecules. M. Cary Lea (Am Jour of Sci–May.) 5000 w.

†31323. Further Notes on the Gold Ores of California. H. W. Turner (Am Jour of Sci–May.) 2000 w.

†31324. On Some Relations Between Temperature, Pressure and Latent Heat of Vaporization. C. E. Linebarger (Am Jour of Sci–May.) 4800 w.

†31325. On the Double Halides of Caesium, Rubidium, Sodium and Lithium with Thallium. J. H. Pratt (Am Jour of Sci–May.) 1500 w.

†31326. Argon, Prout's Hypothesis, and the Periodic Law. Edwin A. Hill (Am Jour of Sci–May.) 4800 w.

*31408. The Production of India-Rubber in British India (*Bd of Tr Jour*–April.) 1100 w.

31415. Water on the Planet Mars. (Extracts.) Camille Flammarion (Lit Digest–May 4.) 1200 w.

†31439. The Law of Mass Action. J. E. Trevor (Am Chem Jour–May.)500 w.

*31441. A Plea for Contractors. Charles A. Ewing (Paving–May.) 2500 w.

31474. Facts About Glass.—The Material in Use Thousands of Years Ago (Bos Jour Com–May 4.) 1200 w.

†31485. Mathematics and Construction in "The Ecole des Beaux Arts." James M. White (Tech–No 9.) 2500 w.

†31487. The Proximate Analysis of Coal. S. W. Parr (Tech–No 9.) 1000 w.

†31492. Address of John C. Trautwine, Jr. (Pro Eng Club of Phila–April.) 17000 w.

†31493. The United States Geological Survey and its Methods of Work. Charles D. Wolcott (Pro Eng Club of Phila–April.) 6400 w.

*31550. An Improved Method for the Microscopic Investigation of Crystals. A. E. Tutton (*Nature*–April 25.) 3800 w.

†31599. Climatic Conditions Shown by North American Interglacial Deposits. Warren Upham (Am Geol–May.) 7500 w.

†31600. The Eruptive Epochs of the Taconic or Lower Cambrian (Am Geol–May.) 2800 w.

†31601. The Nipissing Beach on the North Superior Shore. F. B. Taylor (Am Geol–May.) 3000 w.

†31602. Central Iowa Section of the Mississippian Series. H. Foster Bain (Am Geol–May) 2500 w.

†31614. Rubber in the Congo Region and East Africa. Letters from Charles J. Zingg and J. H. Camp, with Notes (Ind Rub Wld–May 10.) 2500 w.

†31615. Dissolution of the Rubber Reclaiming Company (Ind Rub Wld–May 10.) 800 w.

Serials.

24462. Graphic Statics. W. W. F. Pullen (*Prac Eng*–Began Aug. 10, 1894—17 parts to date—30 cts. each).

27198. Refrigeration and Ice-Making (Sta Eng–Began Nov., 1894—5 parts to date—15 cts. each).

28838. The Contributions of Chemistry to the Methods of Preventing and Extinguishing Conflagrations. Thomas H. Norton (Jour Am Chem Soc–Began Feb.—3 parts to date—45 cts. each).

29531. A History of the Last Quarter Century in the United States. Ill. E. Benjamin Andrews (Scrib Mag–Began March—3 parts to date—30 cts. each).

30858. The Natural Soda Deposits of the United States. Thomas M. Chatard (Jour Fr Inst–Began April—Ended May—2 parts—45 cts. each).

31006. Geological Development of the Australian Continent. A. C. Gregory (*Aust Min Stand*–Began Feb. 23—Ended March 9—3 parts—30 cts. each).

31105. Technical Chemistry. F. W. Streatfield (*Chem Tr Jour*–Began April 13—Ended April 20—2 parts—30 cts. each).

31336. British Fuses for Modern Guns. Ill. (*Eng*–Began April 19—1 part to date—30 cts).

BOOKS OF THE MONTH

The Standard Dictionary of the English Language upon original plans designed to give, in a complete and accurate statement, in the light of the most recent advances in knowledge, and in reduced form for popular use, the orthography, pronunciation, meaning, and etymology of all the words and the meaning of idiomatic phrases in the speech and literature of the English speaking people. Prepared by more than two hundred specialists and other scholars under the supervision of Isaac K. Funk, D. D., editor-in-chief, Francis A. March, LL. D., Ph. D., consulting editor, Daniel S. Gregory, D. D., managing editor. Associate editors, John Denison Champlain, M. A., Rossiter Johnson, Ph. D., LL. D., Arthur E. Bostwick, Ph. D. Volume II, M. to Z. New York, Funk & Wagnalls Co, London and Toronto, 1895. Printed in the United States. [2318 pp., "9×12," full morocco and gilt.]

In estimating a work of this kind at its true value, the exercise of caution with judgment is needed. The publishers have sent it out to reviewers accompanied by prepared reviews evidently with a purpose to form favorable opinion in advance of critical examination. The ostensible object of sending these reviews, as announced, is to aid reviewers in a task which, if adequately performed, would involve much time and labor in examination, and comparison. As in this review we must imitate what in the dictionary itself appears to be almost inimitable in degree, the feat of compressing into word-space the very ultimate of meaning it can contain, we can only give the impression made by a careful comparison of the claims of the publishers with what they have achieved.

The principal features and claims are substantially as follows: (*a*) Unprecedented comprehensiveness in the vocabulary. (*b*) The ordinary meanings of words have first place in definitions. Etymology follows definition,—the proper and logical place for it. (*c*) Differences in spelling and pronunciation in cases where current practice differs have been referred to an advisory committee of able philologists who have authoritatively established the best modern usage. Geographic names follow in their orthography the decisions of the U. S. Board on Geographic names. The spelling of chemical terms has been simplified in deference to the desire of the chemical section of The American Association for the Advancement of Science. (*d*) The modern drift toward simpler spelling has been allowed due weight, without overstepping the limits of practicability, and in all cases of dipthongal forms still much used, both the simplified spelling and that hitherto employed are given, the simplified spelling taking precedence. Differences of American and English usage in words like labor (English, *labour*), etc., are recognized by giving both forms a vocabulary place, the simpler form taking precedence. (*e*) Pronunciation has been indicated by the use of the scientific alphabet, used by the American Philological Association and adopted by the American Spelling Reform Association; and this is justly held to be a more accurate method of indicating pronunciation than has before been adopted in a dictionary. (*f*) Words coined at the caprice of authors and in their nature not likely to enter permanently into the language, have been rigidly excluded, not by the decree of a single editor, but after careful consideration by a committee of representative scholars. (*g*) The definitions are thorough, all such as in the sciences, the arts, and the professions, required special treatment having being referred to trained specialists in the science, art or profession to which they relate. (*h*) An improved treatment of synonyms and antonyms has been adopted. (*i*) Ample exemplifications of the correct use of prepositions are given;—a very useful feature, especially to foreigners desiring to speak and write English with propriety. (*k*) An attempt, (the difficulty of which can hardly be appreciated except by professional editors) has been made to reduce compounding of words to a scientific system. No previous effort to do this in a dictionary has succeeded, though it has been feebly essayed with varying degrees of failure. The use of the German double hyphen for compounded words in place of the single hyphen, reserving the latter for divided simple words, is a commendable feature that might advantageously be imitated in all printing. (*l*) A system of grouping has been used whereby, under the name of some leading word, e. g., "*coin*," "*constellation*," etc., a vast amount of fact is compressed into a minimum of space; we have already spoken of this feature as unprecedented in the manner of its execution and seemingly almost inimitable. (*m*) Syllabication is based upon pronunciation, as a rule for the division of words at ends of lines in writing and printing;— the only rule that can secure uniformity in this respect.

Aside from the claims made for superior pictorial illustration, typography, and binding, which are easily verified by the eye of any competent judge of merit in these arts, the above are the principal features upon which claims for the superiority of the work are based, and the bare statement of them indicates that the publishers commenced the work with perfectly clear and comprehensive ideas of what an English dictionary ought to be, and what it could be made with a sufficient amount of talent, time, and expenditure.

Has it realized the ideal? Doubtless the publishers themselves would candidly admit that there are some points in which they have failed to accomplish their task to their entire satisfaction. The realization of a high ideal is always difficult. But, after very careful examination, with the special object to discover whether the claims are justified in the work itself or not, we are compelled to join in the general outburst of approval which this book has met from scholars and critics in all English speaking lands. In doing this, we candidly confess that a kind of affection for other dictionaries, born of long acquaintance and use, has somewhat obstructed the formation of the opinion we have expressed, and we might perhaps have been more pronounced in its expression, had it not been for a reluctance—probably felt at times by all book-lovers—to let new friends usurp the place of old ones.

The vast learning, minute painstaking, and careful supervision that have been focused upon the preparation of this work, is evident on every page and in every definition. Only a most rigidly enforced system, governing every one concerned in its production could have resulted in so large a measure of success.

ELEMENTS OF MECHANICAL DRAWING. USE OF INSTRUMENTS, Geometrical Problems and Projection. By Gardner C. Anthony, A. M., Professor of Drawing in Tuft's College, Dean of the Bromfield-Pearson School, Member of Am. Soc. of M. E. Boston, U. S. A.: D. C. Heath & Co., 1894. [98 pp. 7½″×5½″ and 32 folding plates 15″×5½″. Price $1.50]

A SERIES of exercises better adapted for use in schools as a text-book for instruction in geometrical drawing than as an aid to more advanced pupils in mechanical drawing. The examples are mostly geometrical. The subject of projection is well treated in the text, and the same may be said of other parts of the treatise, although its scope is somewhat limited.

BOOKS RECEIVED.

J. J. Crawford, State Mineralogist, State Mineralogist.=12th Report of the State Mineralogist (Second Biennial), Two Years, ending September 15, 1894. California State Mining Bureau. Sacramento: A. J. Johnston, Supt. State Printing, 1894. [Octavo, 551 pp., flexible covers.]

New York Railroad Club. Proceedings of the meeting held Thursday evening, March 21st, 1895. Topical discussion. [18 pp., 6″×9″, paper.]

City Engineer's Report, 1894, Binghamton, N. Y. S. E. Monroe, City Engineer. [17 pp., 6″×9″, paper.]

University of Wyoming, Laramie, Wy. Departments of Chemistry and Chemical Engineering. Special bulletin, January, 1895. The Heating Power of Wyoming Coal and Oil, with a description of the Bomb Calorimeter. By Edwin E. Slosson, Professor of Chemistry and L. C. Colburn, Professor of Mechanical Engineering.

Brakes for Light Railways, being a discussion of Question XX at the 5th Session of the International Railway Congress, London, 1895. [33 pp., 7″×10″, paper.]

Boilers, Fire-backs and Tubes, being a discussion of Question V discussed at the International Congress, 5th Session, London, 1895. Reprinted from the Congress Bulletin. [74 pp., 7″×10″, paper.]

New York Railroad Club. Constitution and By-laws and list of members, published by the club. John A. Hill, Secretary, 256 Broadway, New York. [14 pp., 6″×9″, paper.]

The Decimal System, being Question XVI discussed at the 5th Session of the International Congress, London, 1895. Reprinted from the Congress Bulletin. [12 pp., 7″×9½″, paper.]

Light Railway Shops. Question XIX discussed at the 5th Session of the International Railway Congress, London, 1895. Reprinted from the Congress Bulletin. [10 pp., 7″×9½″, paper.]

The Twenty-four Hours Day, being question XV discussed at the International Railway Congress, London, 1895. Reprinted from the Congress Bulletin. [15 pp., 7″×9½″, paper.]

Organization. Question XIII discussed at the International Railway Congress, London, 1895. Reprinted from the Congress Bulletin. [13 pp., 7″×9½″, paper.]

Station Working. Question X discussed at the International Railway Congress, London, 1895. Reprinted from the Congress Bulletin. [61 pp., 7″ ×9½″, paper.]

Duty Trial of the Pumping Engine for the Louisville Water Company, Louisville, Kentucky. By F. W. Dean, Boston. Reprinted from Volume XVI of the transactions of the American Society of Mechanical Engineers, together with reports of experts. [63 pp., 6″×6″, paper.]

Statistics of the American and Foreign Trades for 1894. Annual statistical report of the American Iron and Steel Association containing complete statistics of the American Iron Trade for 1894 ; also a brief review of its present condition ; also complete statistics of the iron ore, coal, pig iron and steel industries of the United States and of all foreign countries for a long term of years. Presented to the members May 15th, 1885, Philadelphia. The American Iron and Steel Association, No. 261 South Fourth St., 1895. [99 pp., 6″×9″, paper.]

25th Annual Report of the Board of Directors of The Lake Shore and Michigan Central Railroad Company for the fiscal year ending Dec. 31st, 1894, Cleveland, Ohio. The Munhall Brothers Company, 1895. [39 pp., 6″×9″, paper.]

The Railroad as an Element in Education. An address before the International Congress of Educators, World's Exposition, New Orleans, by Prof. Alex. Hogg, M. A., Superintendent Public Schools, Fort West. Edition of 1892 with addenda. Louisville. Printed for the author, 1892. [69 pp., 6″×7½″, paper.]

Report of the City Engineer of the City of Troy, for the two years ending February 28th, 1895, including the work done under the inspection of the public improvement commission from the date of its Third Annual Report, February 28th, 1893, to the time of the abolishment of the Commission and the merging of its work into the City Engineer's Department, June 30th, 1893. By Morris R. Sherrerd, City Engineer. [54 pp., 6″×9″, and one folding map showing existing sewers, and granite, brick and asphalt pavement to accompany engineer's report, and six folding sheets containing tables of dimensions, cost of work, and other statistical information.]

New York Railway Club. Discussion of the Chicago plan of Interchange. Meeting of April 18th, 1895. Published by the Club, John A. Hill, Secretary, 256 Broadway, New York. [17 pp., 6″×9″, paper.]

Boiler Review. A publication issued for the perusal of those interested in Steam Boilers, in which are technically reviewed theory and practice relating to the design, construction and application of stationary, marine and locomotive boilers with a view of helping those connected with their use or purchase to form an opinion as to the merits and demerits of all boilers, unbiased by certain prejudices due to erroneous assertions and claims made in behalf of many constructions. Hogan Boiler Co., Middletown, New York, U. S. A. [196 pp., 7″×9″, paper.]

The Transporting Power of Water as Applied to the Deepening and Improvement of Rivers, with a description of "The Eroder" by W. H. Wheeler, M. Inst. C. E. Boston, J. M. Newcomb, 1895. [20 pp., 5½″×8″, paper.]

Report on the Chicago Strike of June-July, 1894, by the United States Strike Commission Appointed by the President, July 26th, 1894, under the Provisions of Section 6 of Chapter 1063 of the Laws of the United States, Passed October 1st, 1888 : With Appendices Containing testimony, proceedings and recommendations, Washington Government Printing Office, 1895. [681 pp., 5¾×″9″, paper.]

13th Annual Catalogue of the Rose Polytechnic Institution, Terre Haute, Ind., with an outline of the course of study and a plan of instruction, 1895. Terre Haute, Ind., Moore & Langdon, 1895. [68 pp., 5⅝″×8½″, paper.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

C. W. Hunt Co., New York, U. S. A.=Pamphlet, 40 pp., 6¾″×9½″. [Gives complete information as to the construction, value and advantages of Industrial Railways for manufacturing establishments. Discusses the topics of what gage is best, what radius curves should be used, how heavy the rail should be, what style will be best, what kind of cross-ties should be used, how switches and crosses should be made, the advisability or unadvisability of turn-tables, the effect of crosses, etc., etc. The whole is thoroughly illustrated with details of construction and will convey all needed information to those who contemplate the construction of this class of railways. Cover, chocolate brown and gold.]

The Short-Conrad Co., Cleveland, Ohio, U. S. A.=Pamphlet, 8 pp., 8″×5¼″. [Describes and illustrates construction and application of the "National" temperature regulator for steam or hot water heaters.]

The Commercial Electric Co., Indianapolis, Ind., U. S. A.=Unpaged sheets eyeletted together. [Illustrations and descriptions of motors, dynamos, power and railway generators. Elegantly printed ; cover, pearl-grey and green.]

The Plume & Atwood Manufacturing Co. New York, U. S. A.=Catalogue, 64 p. [Describing a long line of brass and copper good, which it requires two pages to index. Goods illustrated as well as described, and in great variety. Elegantly bound in indigo, blue, and gold; flexible cover with rounded corners.]

Hine & Robertson Co., New York, U. S. A. =Catalogue, unpaged. [Steam specialties, including indicators, reducing wheels, and chronometers; with price-lists and illustrations.]

Randolph & Clowes, Waterbury, Conn., U. S. A =Catalogue, 20 p. [Illustrating and describing seamless drawn, copper, range-boilers, seamless brazed brass and copper tubing and moulding, seamless drawn brass and copper shelves, brass kettles, plumbers' supplies, etc.]

H. M. Bates Machine Co., Boston and New York, U. S. A.=Catalogue, 160 p. [Machinery for transmission of power, pulleys, hangers, pillow blocks, friction clutches, counter-shafting, shippers, gears, and also a line of steam boilers and engines. Five pages of index; beautifully printed, octavo, flexible cover, olive green and gold.]

The J. D. Smith Foundry Supply Co., Cincinnati, Ohio, U. S. A.=Supplementary catalogue No. 22, 16 p. [Describing and illustrating tumbling barrels, exhaust pans, sand-blast apparatus, sand-blast tumbling barrel, etc.: with leaflets from other catalogues, describing radiant facings, pattern letters and figures, riddles, wire, wheels, brushes, &c.] Also Supplementary Catalogue No. 16, 8 p. [Describing and illustrating trowels, slicks, gate-knives, flutes, and other hand instruments for moulding.]

John S. Thurman, M. E., Indianapolis, Ind., U. S. A.=Catalogue, 3 pp. [Describes the Thurman's Oil Burning System, with illustrations of its applications to steam boiler forges, ovens for baking artificial teeth, brick kilns, ovens for drying sand, coal, marl, ores, infusorial earth, and other animal, vegetable, and mineral materials. Printed on coated paper. Cover maroon and gold.]

D. Van Nostrand Co., New York, U. S. A. =(1)Catalogue, 57 pp., 5½" × 9". [Contains a list, with prices, of the scientific, military and naval publications of this company, including Weale's Rudimentary Series.]

(2) Catalogue, 64 pp., 5½" × 9". [Contains a list, with prices, of the books on chemistry, chemical technology, and physics, published and sold by this company.]

(3) Catalogue, 64 pp., 5½" × "9. [Contains a list, with prices, of the books on electricity, electric light, the telephone, electro-motors, electric telegraph, electro metallurgy, &c., published and for sale by this company.]

Alberene Stone Co., Boston, Mass., U. S. A. =Catalogue, 32 pp., 10"×6½". [Describes and illustrates a long line of soap-stone goods manufactured from the Alberene stone, derived from the quarries at Alberene, Va. Also contains price list. Elegantly printed on coated paper, with cover in pea-green, red and gold.]

Follansbee Bros. Co., successors to James B. Scott & Co., Pittsburg, Pa., U. S. A.=Pamphlet, 12 pp., 6"×6". [Contains facsimiles and copies of letters received by this company, evidencing the high quality of "The Scott's Extra Coated" guaranteed roofing tin.]

Giblin & Co., Utica, N. Y., U. S. A.=Catalogue 20 pp., 4⅝"×7¼". For dealers only. [Describes and illustrates the Furnaces and Combination Heaters manufactured by this Company. Cover blue and gold.] (2) Catalogue, 40 pp., 4⅝"×7¼". For retail customers only. [Also describes the furnaces and combination heaters manufactured by this Company, but gives full explanation and directions to those who will erect and use them. Price list supplied in the first named catalogue.]

Marine Iron Works, Chicago, Ill., U. S. A.= Pamphlet, 32 pp., 6"×9". [Describes a line of the marine machinery and complete steam yachts and launches manufactured by this Company, including several illustrations of engines, launch engines, marine engines, boilers in variety, the Roberts Safety water tube boiler, with illustrations of complete steam launches, and views of interiors of yachts, etc. The whole is handsomely printed and bound in pearl-gray cover.]

E. T. Barnum, Detroit, Mich., U. S. A.= Catalogue 120 pp., 7"×10½". [Describes and illustrates a long list of wire and iron goods.]

The Ingersoll-Sergeant Drill Co., New York, U. S. A.=Catalogue, 115 pp., 10"×8". [This is the 1895 coal mining catalogue No. 50, published by this company. It relates to coal-mining machines, air compressors, and general coal-mining machinery and appliances in great variety. A large number of the illustrations show the machines as in actual use,—a method of representation which greatly aids the reader in comprehending the value of these improvements. Price lists are also given.]

Hogan Boiler Co., Middletown, New York, U. S. A.=Twenty-five leaflets, eyeleted together, printed on one side only. [Each contains a plate illustrating different details of the construction and erection of the 400 h. p. Hogan boiler (manifold type) recently supplied to the State Homeopathic Asylum for the Insane, Middletown, New York.]

The Ferracute Machine Co., Bridgeton, New Jersey, U. S. A.=Catalogue 11, 1895, 32 fold-in pages, 12"×9¾". [Illustrates and describes new designs of foot and power presses, lathes, beaders, dies, &c., for working various kinds of bar and sheet metals. Over 300 sizes and kinds of presses are described, and a number of them are illustrated. Tabulated information is also given.]

P. H. & F. N. Roots Co., Connersville, Ind., U. S. A.=Pamphlet, 18 pp., 10"×7". [Describes and illustrates Roots' rotary positive pressure blower, with recent improvements. Gives table of specialties and capacities of blowers for cupolas, with principal dimensions of blowers and other useful information.]

New York Central Iron Works Co., Geneva, N. Y., U. S. A.=Catalogue 65 pp., 10"×6⅛".

[Describes and illustrates the "Dunning" boilers, both of the magazine and surface burning types, showing the manner of their setting in brick, also illustrating and describing the portable boilers manufactured by this Company and giving price list.] (2) Catalogue of the Dunning Hot Water Heater. [Description and illustration of the hot water heaters manufactured by this Company for warming buildings. Elegant covers in olive green and gold.]

Anderson and Dickey, Boston, Mass., U. S. A.=Catalogue 52 pp., 5½″×8″. [Describes and illustrates an extensive line of architectural wood turning, spiral moulding, stair posts, baluster rails, etc.]

J. F. Pease Furnace Co., Syracuse, N. Y., U. S. A.=Catalogue 72 pp., 7″×10″. [Describes and illustrates the Economy Combination Heaters, steam heaters, hot water heaters, and warm air furnaces for which this firm has become famous. The combination system was succesfully originated by Mr. John F. Pease of this Company, and the first successful heater of the class was made and erected in 1882. Probably no heating device since invented has ever achieved a greater success than has this. A large portion of the catalogue is taken up in the way of testimonials from those who have used the goods put on the market by this firm. Tables of weight, dimensions, capacities, &c., are appended.]

T. C. Joy & Co., Titusville, Pa., U. S. A.=Pamphlet 40 pp., 9″×7″. [Describes and illustrates the radiators manufactured by this firm, together with engravings of large and important buildings in which these goods have been used. Elegantly printed, tinted engravings; cover, buff, pale green and deep violet.]

The Continental Iron Works, Brooklyn, N. Y., U. S. A.=Pamphlet, 24 pp., 9″×11″. Cover, stiff cloth, red and gold. [Describes and illustrates the Morison Suspension Furnaces; gives a long list of steamers using the furnaces; contains tables of pressure and thickness, with rules for calculating the same, as applied to the Morison Suspension Furnaces; plates, with full-size details of corrugation; diagram illustrating pipes of Morison Suspension Furnaces with plain ends, and also with flanged ends; diagrams illustrating interchangeable types of the Morison Suspension Furnaces; data necessary for estimating and for manufacturing purposes; diagrams illustrating types of flanging Morison Suspension Furnaces; and patent combustion chamber bottom, sectional diagrams, and end-views of land boilers fitted with Morison Suspension Furnaces, and the Morison Patent Furnace Door and Frame for marine and land boilers. A partial list of steamers to which the Morison Suspension Furnaces have been fitted fills four of the large pages of this pamphlet.]

The Ingersoll-Sergeant Drill Co., New York, U. S. A.=Advanced sheets of catalogue No. 40, 1895, 72 pp., 8″×10½″. [Describes and illustrates rock drills, quarry bars, gadders, stone-channeling machines, and special quarrying machines manufactured by this company. A large fund of useful information is contained within the covers. We are informed that the complete catalogue will be ready early the present season.]

Detroit Heating and Lighting Co., Detroit, Michigan, U. S. A.=Pamphlet, 56 pp., 6″×8″. "Light for Evening Hours." [The bulk of the book consists of a description of the combination gas machine manufactured by this company, with illustrations of many elegant buildings which are lighted by gas produced by the machine, which, though one of the oldest of its class, is fully up to date in the matter of sterling improvements which render its use satisfactory in every situation for which it is adapted. A catalogue of heating stoves and gas grates,—of which the company manufacture a long line,—as well as of the necessary fixtures for burning manufactured or natural gas, cooking utensils for use with stoves, etc., is appended. A leaflet describing the combination mixing regulator used with perfect success in gas-ranges, gas-logs, etc., is inserted. Another leaflet containing an important testimonial relating to the availability of the gas manufactured by the combination gas machine above spoken of for use with the Wellsbach system of incandescent lighting, also accompanies the catalogue. Like all the trade publications issued by this company, this pamphlet is elegantly printed and illustrated with beautiful half tone and line engravings and bound in an elegant cover,—canary-yellow and dark blue.]

The Deane Steam Pump Co., Holyoke, Mass., U. S. A.=(1) Catalogue, 12 pp., 8″×4″. [Describing the Deane pumping apparatus for artesian wells.] (2) Catalogue, 8 pp., 3½″×6″. [Describing the Deane automatic receiver.] (3) Catalogue, 16 pp., 3½″×6″. [Describing and illustrating the Deane specialties, including latest and most improved designs of their special classes of pumps.] (4) Catalogue, 8 pp., 3½″×6″. [Describing and illustrating the Deane triplicate power pumps.]

Orr & Sembower, Incorporated, Reading, Pa., U. S. A.=Catalogue J, 1895, 86 pp., 3″×6″. [Describes and illustrates vertical, horizontal, marine, and hoisting engines and boilers in great variety, with price list. Cover, buff and light brown.]

The Hayden & Derby Mfg. Co., New York, U. S. A.=Catalogue, 32 pp., 6″×9½″. [Metropolitan Injectors, and also some well-compiled and -prepared information in reference to injectors in general, with descriptions and illustrations of the Metropolitan injectors and price list.]

The Cincinnati Corrugating Co., Piqua, O., U. S. A.=Illustrated catalogue, 1894. 63 pp., 6″×9″. [Describing corrugated roofing, siding, ceiling, arches, lath, shutters and doors, V-crimped iron roofing, standing seam plain roofing, roll and cap steel roofing, Outcalt elastic joint roofing, metallic weather bars, ridge capping, peaked metallic ceiling and roofing tin plates, and Juniata galvanized sheets "Piqua brand." Cover, black and gold.]

The Cady Mfg. Co., Cleveland, O., U. S. A.=Catalogue, 24 pp., 3⅜″×6″. [Describing and illustrating a long line of machine tools for forging, punching, shearing wire, work, sheet metal work, etc. Cover, blue and gold.]

Richardson & Boynton Co., New York, U. S. A.=Pamphlet, 7 pp., 6″×9″. [Describes and illustrates the new "Perfect" hot air blast for boiler furnaces, patented and placed on the market by this house. Very remarkable claims for the economy secured by the use of this system are made. A perfect comprehension of the application of the device may be gained from the pamphlet.]

Murray & Tregurtha, South Boston, Mass., U. S. A.=Catalogue, 39 pp., 9″×6″. [Describing and illustrating steam yachts and launches, the Tregurtha water tube boilers, single, combined, triple, and quadruple expansion marine engines, propeller wheels, etc.]

The Jeffrey Mfg. Co., Columbus, O., U. S.A. =Catalogue, 144 pp., 5″×7½″. [Describing and illustrating chain belting, steel cable conveyors, labor-saving appliances, elevators, carriers, power-transmission machines, mill, factory and mine supplies, and mining machinery. [Cover, pearl-gray and blue.]

The Dunn Mfg. Co., Limited, Pittsburg, Pa., U. S. A.=Catalogue, unpaged, 6″×9″. [Describes and illustrates the extensible sewer brace manufactured by this company, and also a line of special tools for contractors' use. Cover, salmon-yellow and violet.]

William T. Comstock, New York, U. S. A.= Catalogue, 66 pp., 6″×9″. [Comprising a list of a long line of standard architectural and building books, together with numerous other technical publications sold by this house. The list is especially copious in works pertaining to architecture and building.]

Dennison Mfg. Co., Boston, Mass., U. S. A. =Pamphlet, 61 pp., 6″ × 9¾″. [Beautifully printed on coated paper with portrait of E. W. Dennison, founder of the company, and a history of the business and of the principal men concerned in it, with portraits, views of buildings, &c. An interesting feature is an account of a distribution made to every employee on the fiftieth anniversary of the existence of the company, amounting to $5 for every full year's service, together with a certificate recognizing valuable services rendered.]

B. F. Sturtevant Co., Boston, Mass., U. S. A. =Pamphlet, 20 pp., 6½″×8½″. [Describing the system of mechanical draft as contrasted with chimney draft, and describing and illustrating the various fan-blowers manufactured by this company for the purpose of producing either forced draft or induced draft, with a list of some of the numerous parties using these appliances. Very neatly printed on good paper with clear illustrations.]

Chas. P. Willard & Co., Chicago, Ill., U. S. A.=Pamphlet, 32 pp., 6″×9″. [Describing and illustrating fore and aft compound engines, compound marine engines, steam yachts, yacht engines, steeple compound engines, steam launch and launch engines, the Willard high-speed marine engine, duplicate marine engine, plain vertical boilers, submerged tube vertical marine boilers, the Clyde boiler, Scotch marine boilers with water backs, stern-wheel river launch, long-stroke marine engines for stern-wheel boats, feathering paddle wheels, light draft, twin-screw launches, steamer steering wheels, propeller wheels, condensers, and yacht appliances in great variety.]

The Meriden Machine Tool Co., Meriden, Conn., U. S. A =(1) Illustrated catalogue and price list, 1895. 32 pp., 6″×9″. [Five pages are left blank, except that the title of the company and the word "Notes" are printed at the top. Describes a line of machine tools, particularly lathes and lathe appliances, turret lathes, self-oiling counter shafts, drill presses, universal joints, etc., manufactured by this company.] (2) Pamphlet, 6″×3⅜″, entitled "Selections from the Poets (and others), with comments." [This is one of the most unique bits of trade literature that has come under our notice. The name of the firm which perpetrates this pleasant joke appears nowhere except on the very last page, whereon is written the sentence; "The perpetrator hopes to be forgiven; an order for (or even an inquiry regarding) a forming lathe will be accepted as evidence of forgiveness." The signature of the firm is appended to this plea.]

M. Mahony, Troy, N. Y., U. S. A.=Catalogue, 19 pp., 8″×6″. [Describing the line of Mahony vertical section boilers for steam or hot water. Printed on heavy coated paper in separate sheets, eyeletted together with pink cord, which attaches a cover of beautiful design in pearl-gray and black.]

The Ludlow Valve Mfg. Co., Troy, N. Y., U. S. A.=Catalogue, 106 pp., 8⅜″×5″. [Describing and illustrating the long line of Ludlow valves and Ludlow hydrants which this company has been putting on the market for many years. Tables of dimensions and price-list are included. Flexible leather cover.]

Sandwich Enterprise Co., Sandwich, Ill., U. S. A.=Catalogue, 64 pp., 6″×9″. [Illustrating and describing, with price list, a long line of wind-mills, wind-mill towers, tanks, pumps, and other hydraulic appliances; also leaflet describing the new ærating pump manufactured by this company for use in purifying pump water, and containing opinions of users as to its efficiency.]

Link-Belt Engineering Co., Philadelphia, Pa., U. S. A.=Catalogue, 19 pp. [Describing power-transmission machinery, including shafting, pulleys, gearing, rope sheaves, fly wheels, friction clutches, general machinery casting, etc., etc., which this company supplies and contracts for, as well as complete power equipments and manufacturing plants of every description. Cover, old gold and purple.]

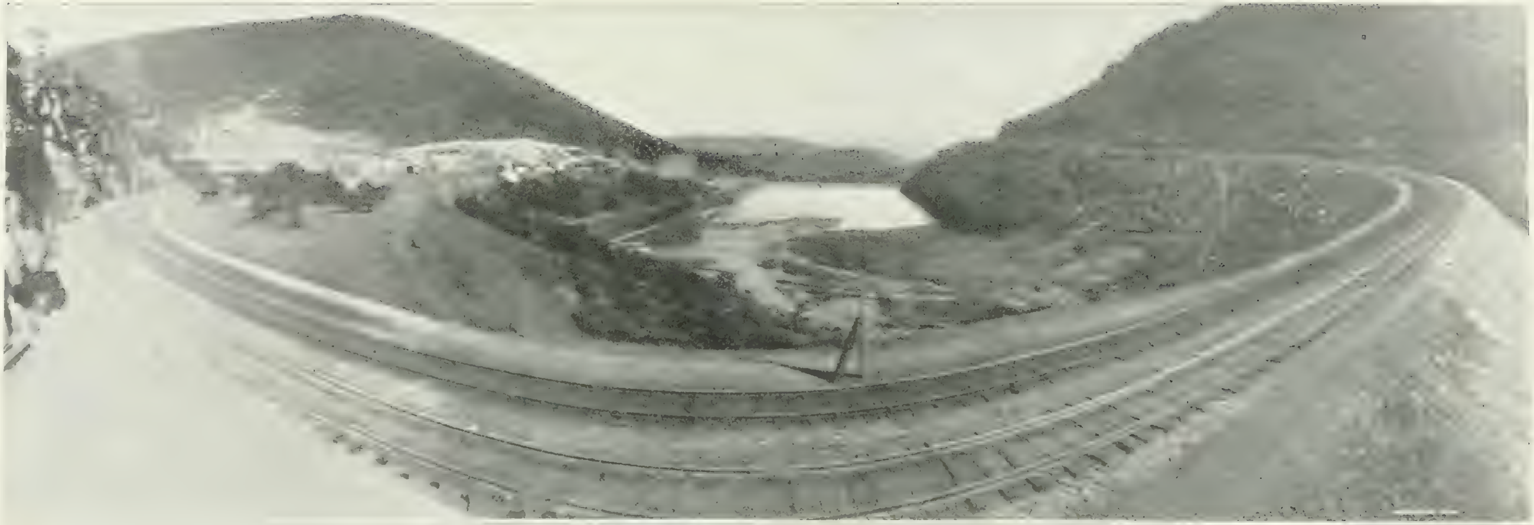
B. F. Sturtevant Co., Boston, Mass., U. S. A.=Illustrated Catalogue, 27 pp., 8½″×6½″. [Describing the Sturtevant automatic upright engines for electric light and general high-grade work. This is beautifully printed on coated paper; cover, dark pink, rose-pink and gold.]

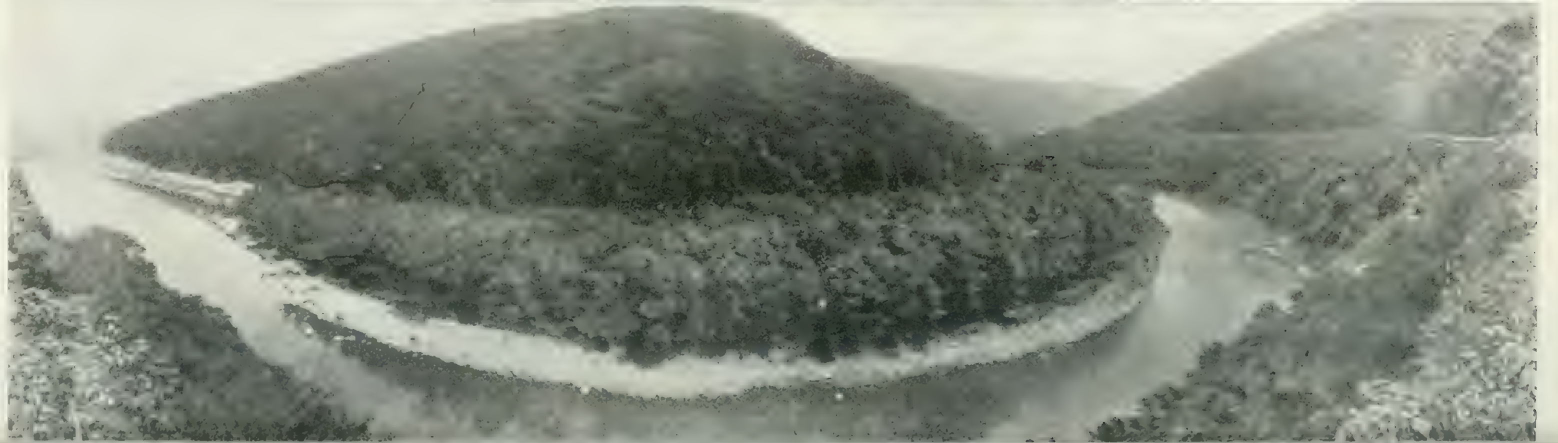
For additional Catalogues see pages under Improved Machinery.

FAMOUS SCENERY

ON

AMERICAN RAILROADS.

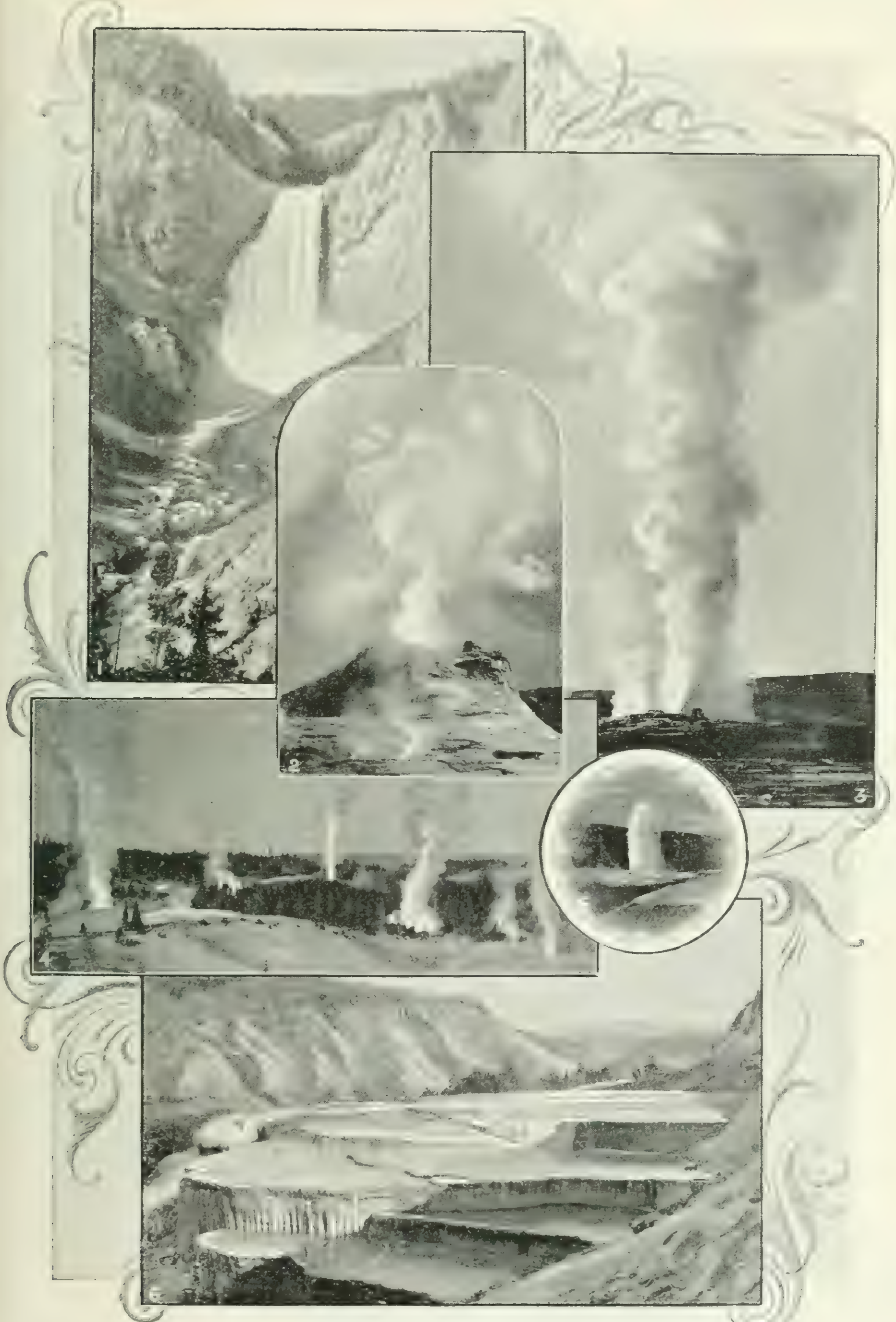




DISTANT VIEW OF MOUNT RAINIER.—NORTHERN PACIFIC R. R.

IN FLATHEAD AND COEUR D'ALÉNE COUNTRY.—NORTHERN PACIFIC R. R.

1. Along the Missoula River. 2. St. Regis River. 3. Mission Range. 4 On St Regis River.
5. Pumpelly Cañon—McDonald Peak—Mission Range

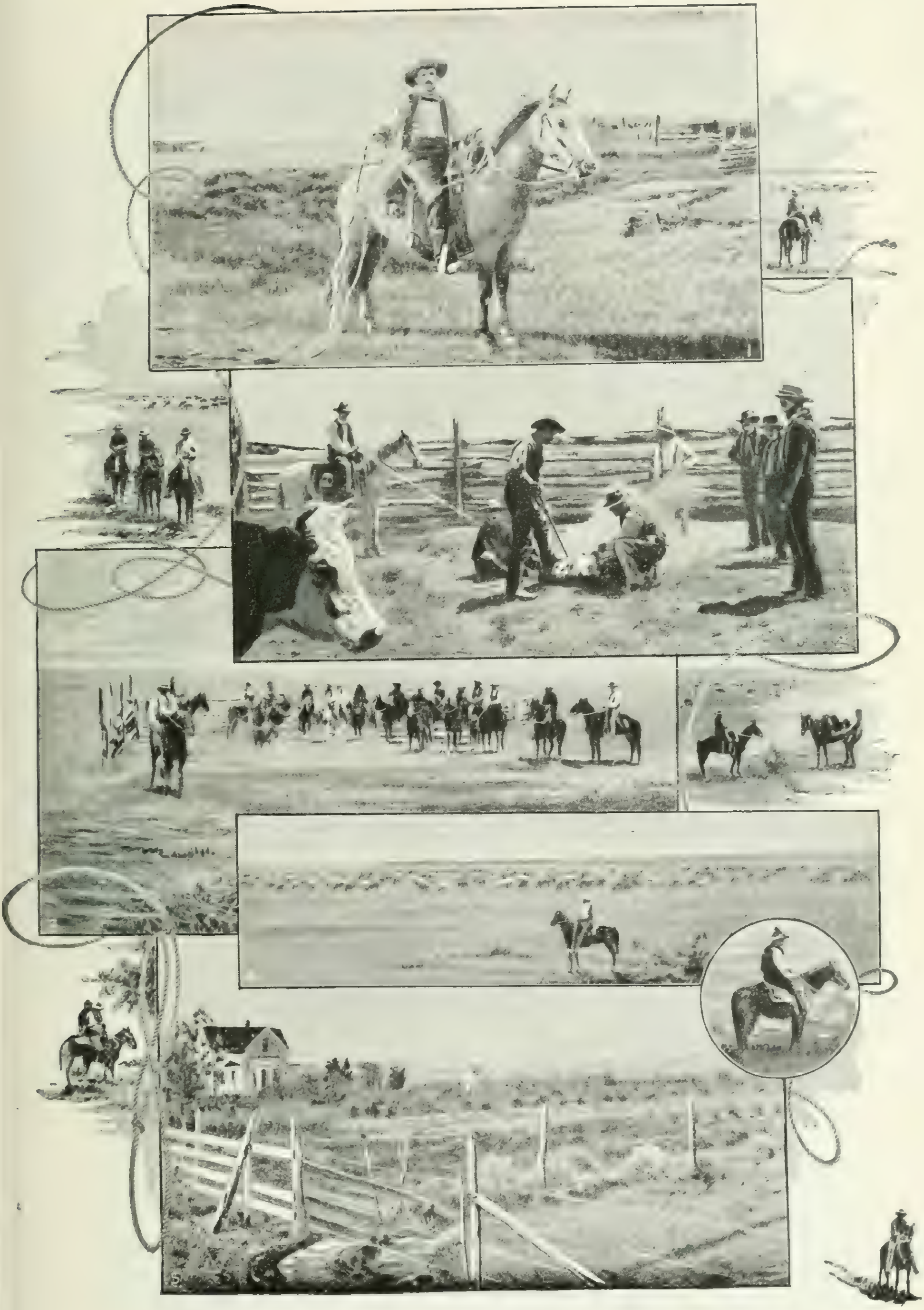


SCENERY IN THE YELLOWSTONE NATIONAL PARK.—NORTHERN PACIFIC R. R.

1. Yellowstone Falls and Cañon. 2. Castle Geyser. 3. Giant Geyser. 4. Norris Geyser Basin.
5 Bee Hive Geyser. 6. Minerva Terrace.

SCENES IN PYRAMID PARK.—NORTHERN PACIFIC R. R.

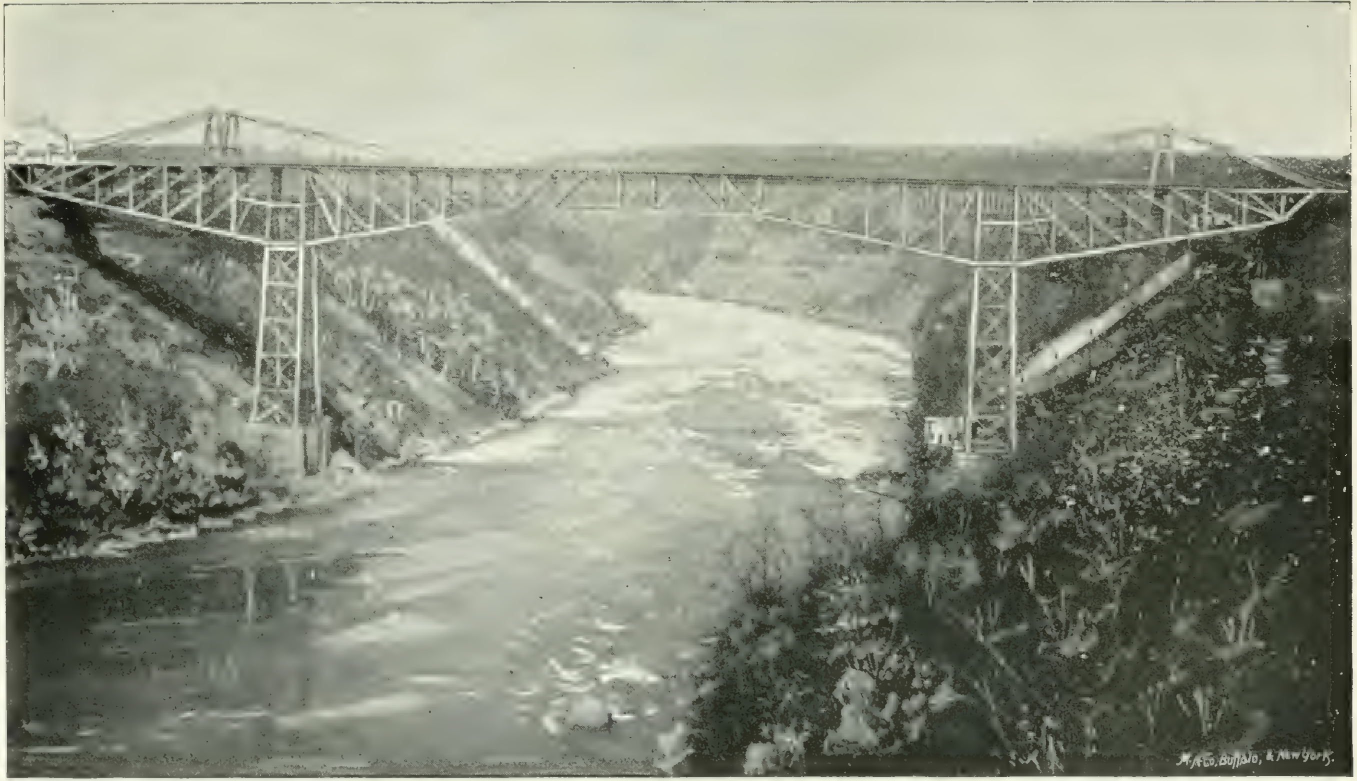
1, 2, 3, 5. Scenes Along Little Missouri River. 4. Watch Dog Rock.



RANCH SCENES IN THE YELLOWSTONE VALLEY.—NORTHERN PACIFIC R. R.

1. Typical Cow Boy. 2. Branding. 3. Cow Boys. 4. Herding. 5. Cattle Ranch.

VIEW OF NIAGARA FALLS FROM THE CANADA SIDE.—MICHIGAN CENTRAL R. R.

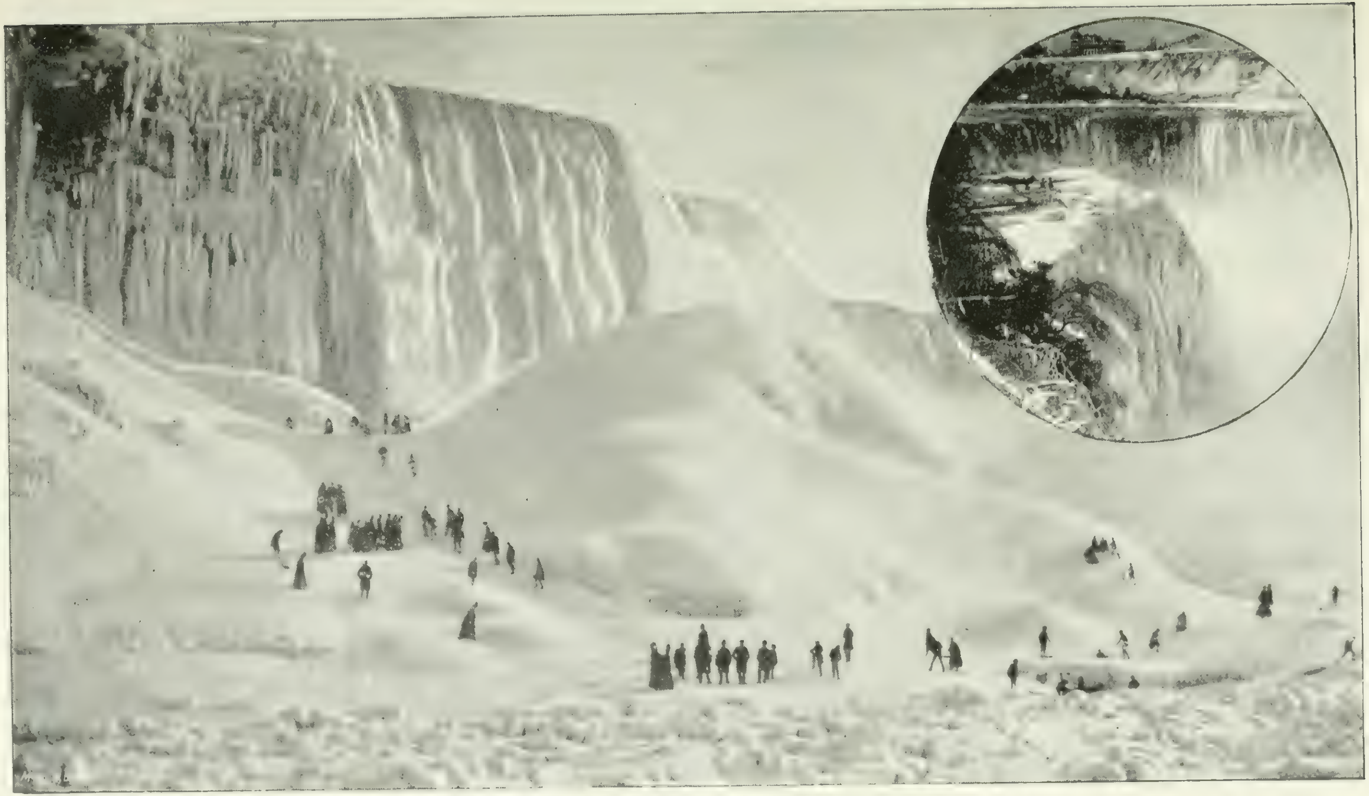


THE CANTILEVER BRIDGE OF THE MICHIGAN CENTRAL AT NIAGARA FALLS.

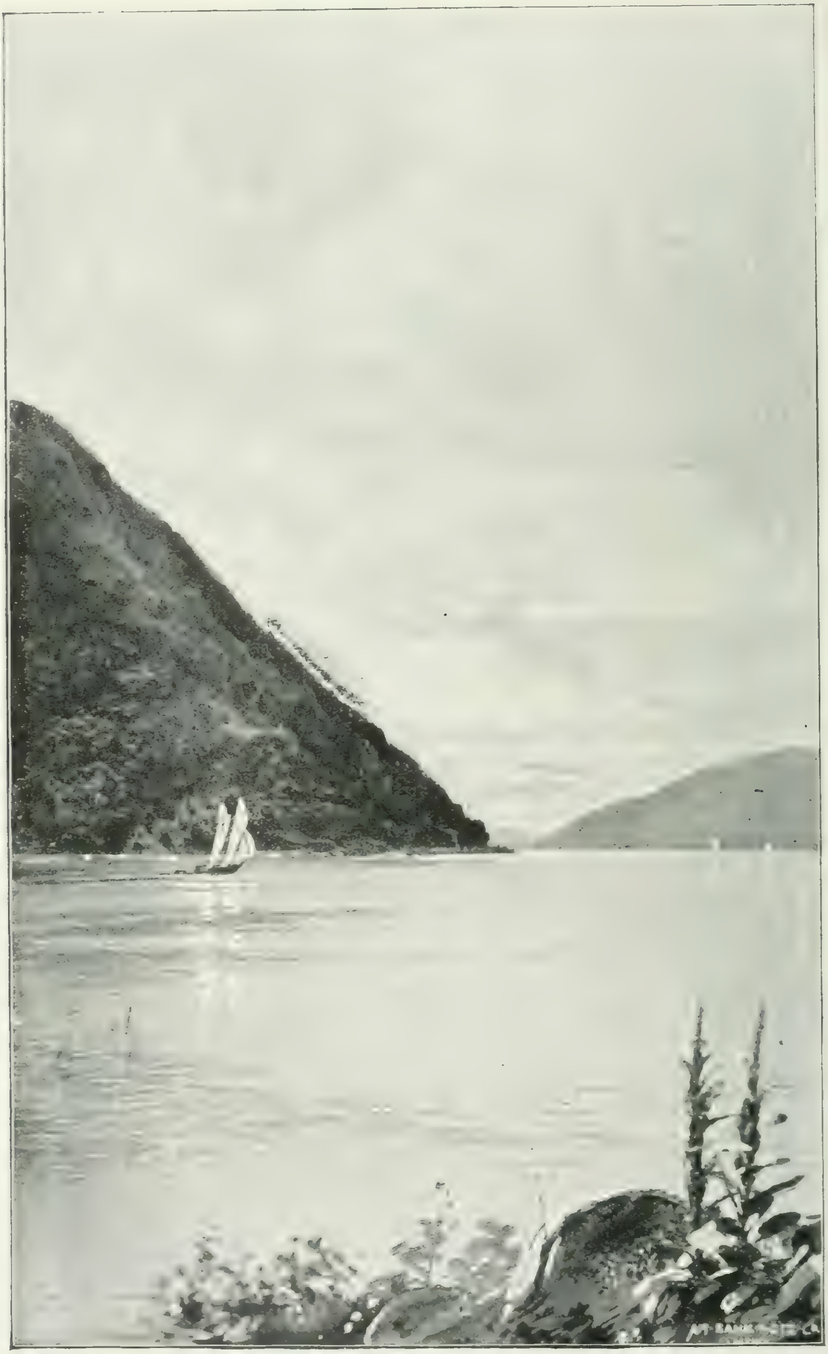
GENERAL VIEW OF THE FALLS FROM PROSPECT POINT.

THE AMERICAN FALLS FROM BELOW GOAT ISLAND.

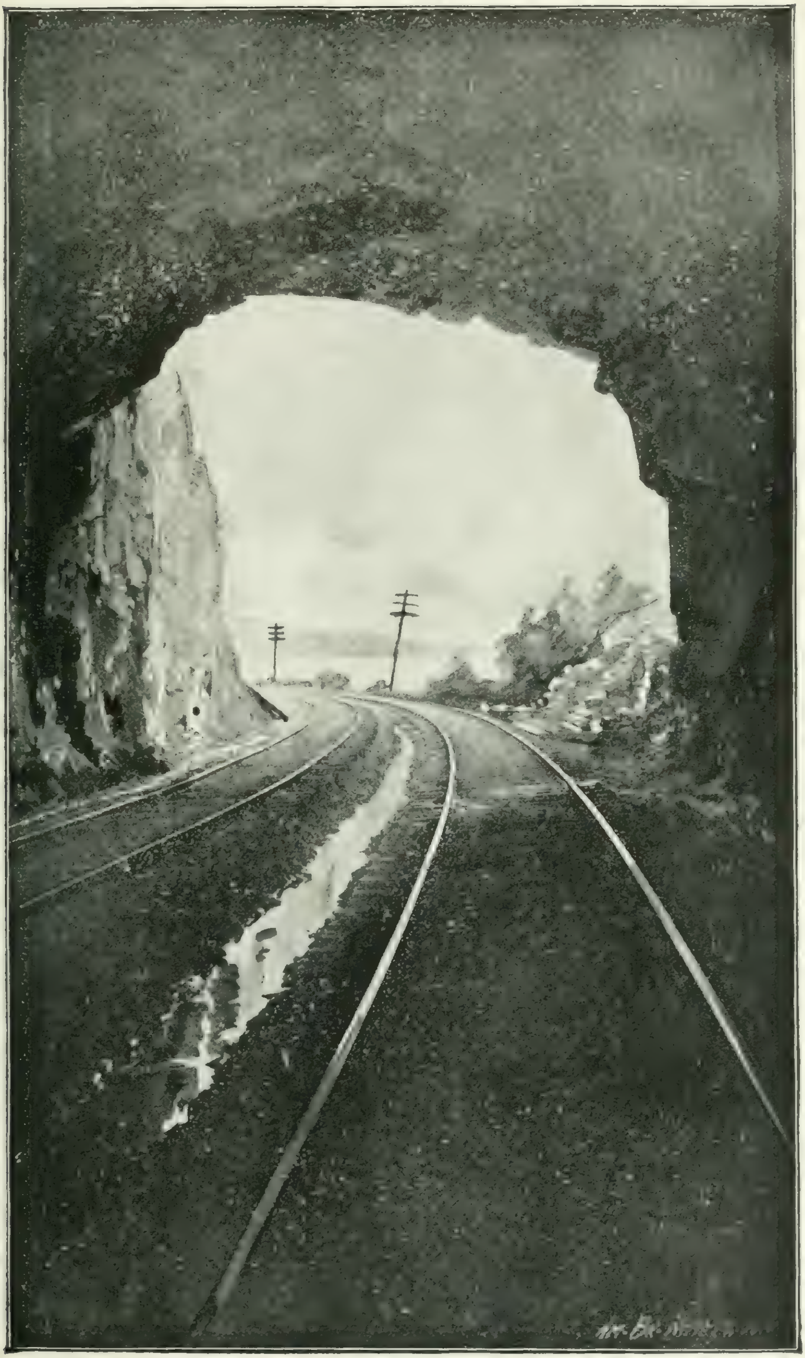
THE HORSE-SHOE FALL FROM GOAT ISLAND.



IN WINTER GARB. ICE MOUNTAIN, FOOT OF AMERICAN FALL, AND THE HORSE-SHOE.



ANTHONY'S NOSE FROM FORT MONTGOMERY, ON THE HUDSON.



LOOKING OUT OF HAVERSTRAW TUNNEL.—WEST SHORE AND ONTARIO & WESTERN R. R.

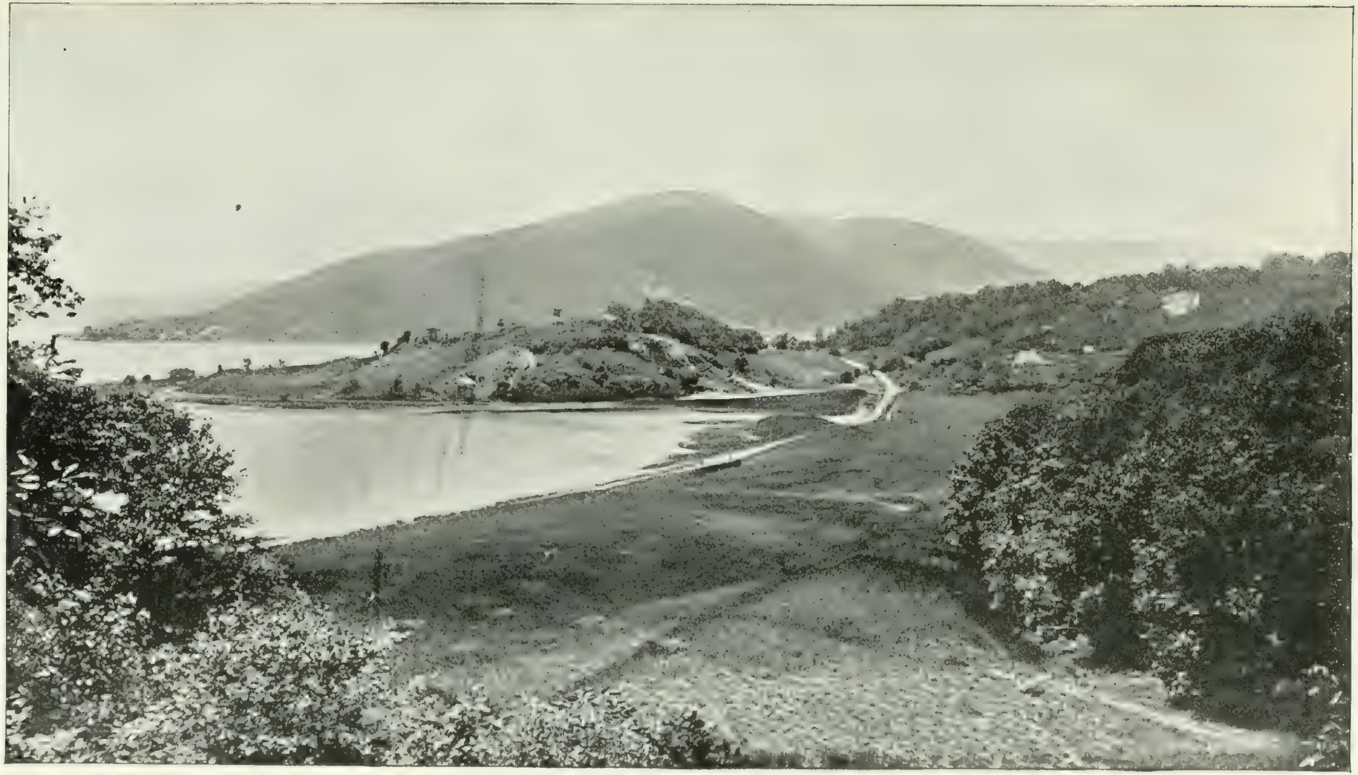
AM. BK. NOTE CO. N.Y.

LOOKING NORTH FROM WEST POINT.—WEST SHORE R. R.

CREST OF THE SHAWANGUNKS, CATSKILL RANGE.—N. Y., ONTARIO & WESTERN R. R.

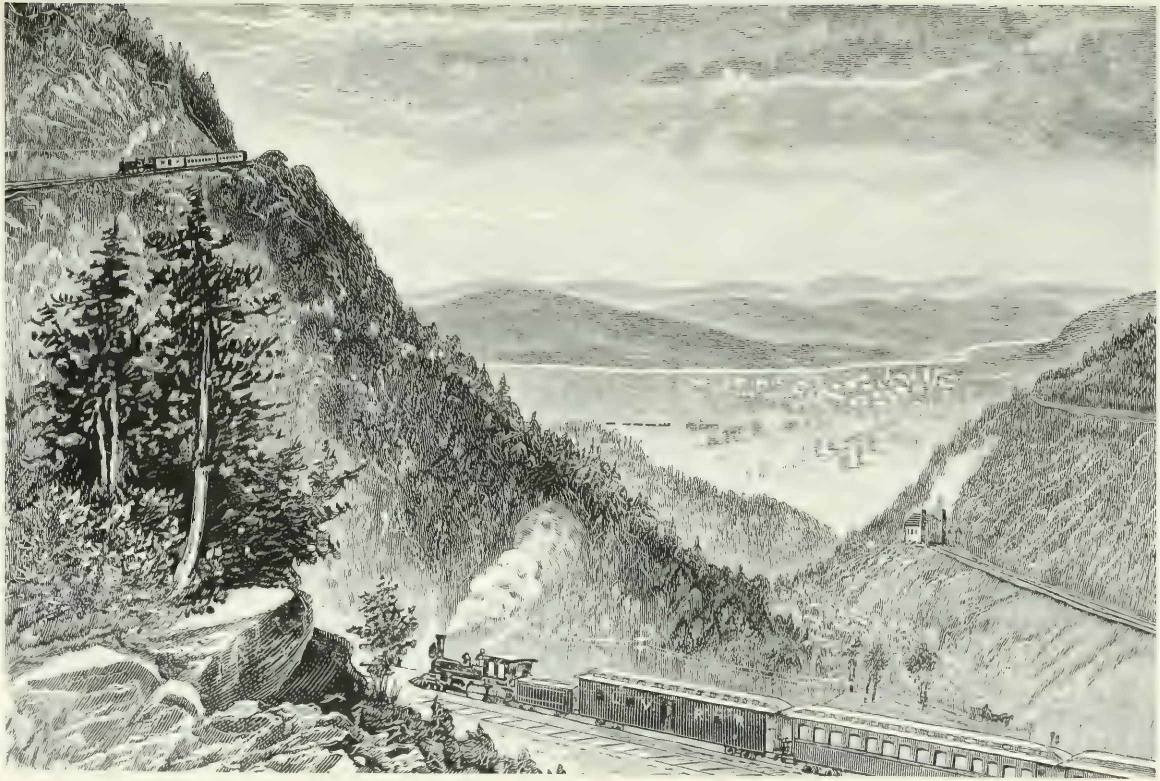
ON THE "SWITCHBACK" IN CASCADE MOUNTAINS, WASHINGTON.—GREAT NORTHERN R. R.

A CATTLE RANCH IN MONTANA.—GREAT NORTHERN R. R.



ROA HOOK, ON THE HUDSON.—SITE OF THE STATE CAMP, NEW YORK MILITIA.—NEW YORK CENTRAL R. R.

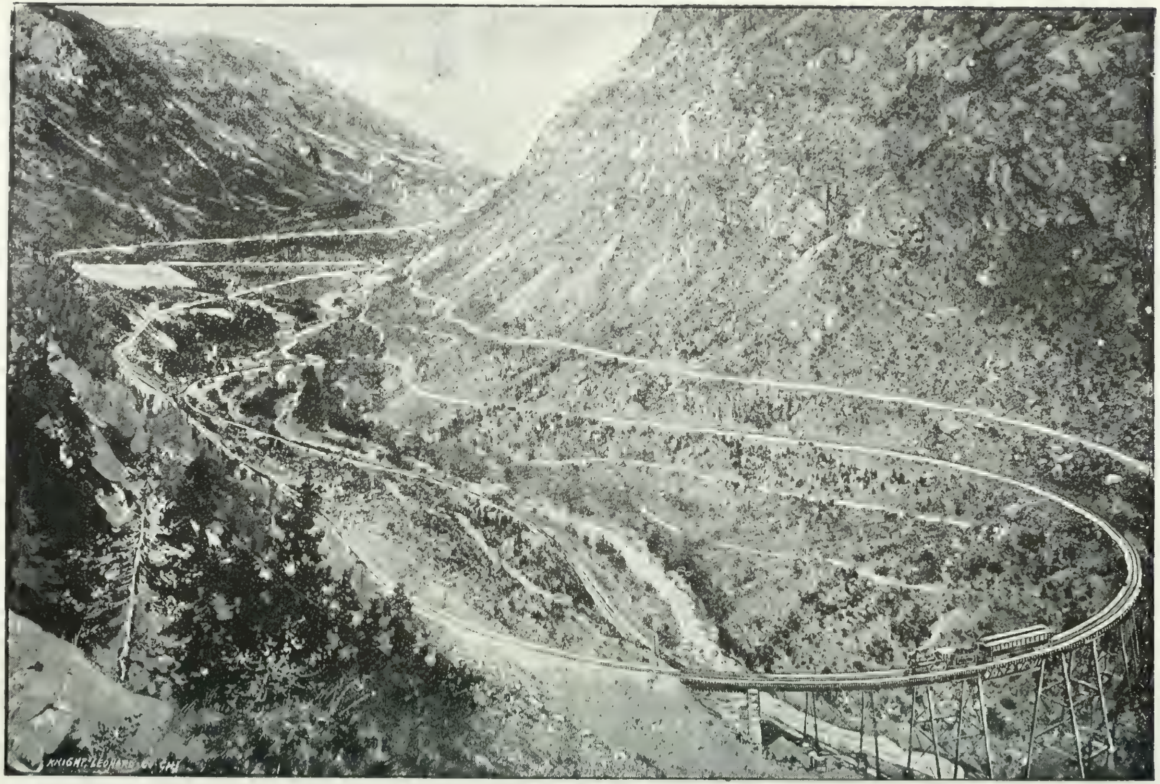
IN THE BLUE RIDGE MOUNTAINS.—CHESAPEAKE & OHIO R. R.



THE WYOMING VALLEY, PA.—LEHIGH VALLEY R. R.

HANGING ROCK, CLEAR CREEK CANON—On the Union Pacific System.

MOUNT OF THE HOLY CROSS, COLORADO.—seen from the Union Pacific System.

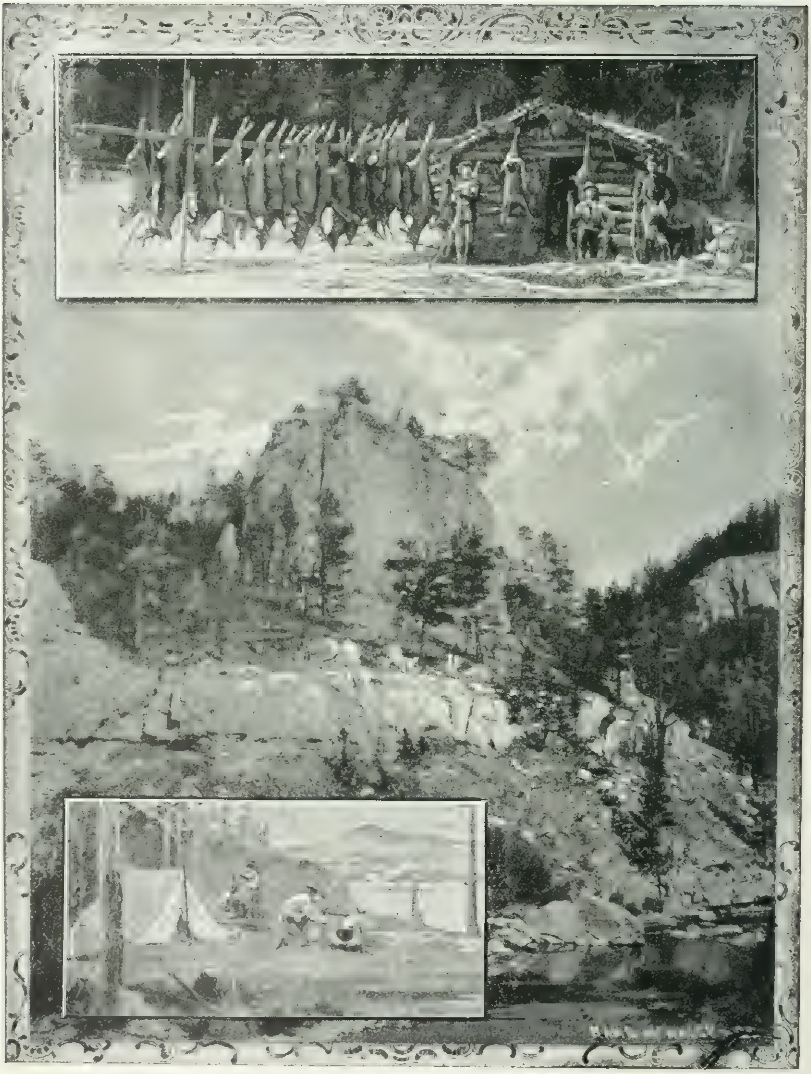


THE LOOP ABOVE GEORGETOWN, COLO.—On the Union Pacific System.

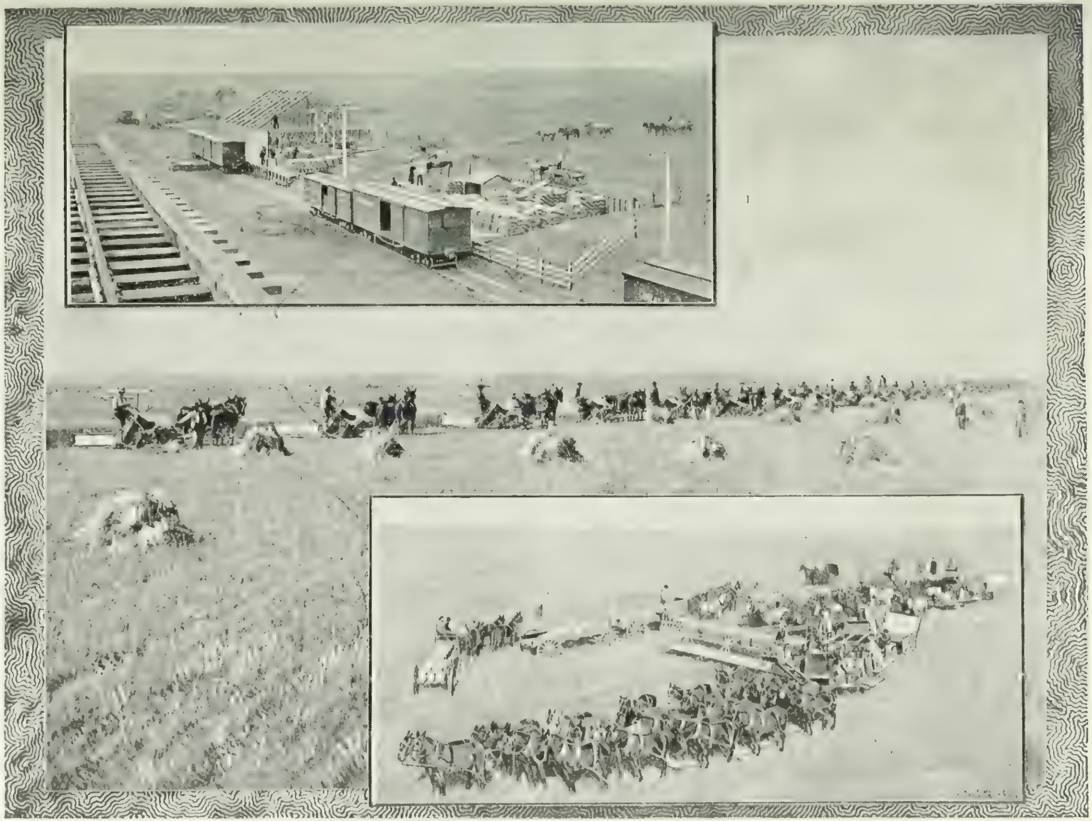
MOUNT ABRAM, OURAY TOLL ROAD.—COLO.

RIO LAS ANIMAS CANON, COLO.—DENVER AND RIO GRANDE R. R.

CATHEDRAL SPIRE, COLO.—DENVER AND RIO GRANDE R. R.

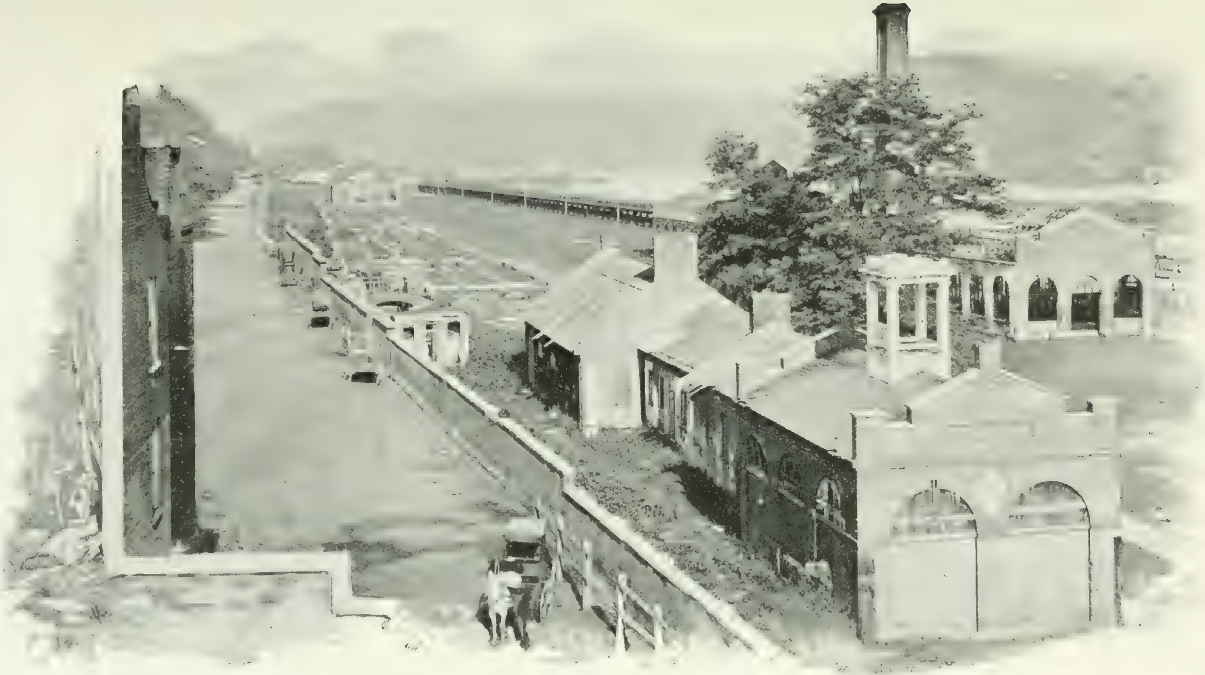


BELT RIVER VALLEY IN BIG BELT MOUNTAINS, MONTANA.



IN THE BIG BEND WHEAT COUNTRY, WASHINGTON.

LAKE MC DONALD, IN THE MONTANA ROCKIES.



JOHN BROWN'S FORT AND THE OLD ARSENAL, HARPER'S FERRY, WEST VA.—BALTO. AND OHIO R. R.

PROFILE ROCK, CASCADE MOUNTAINS, WASHINGTON.

IN TUMWATER (TALKING WATER) CANYON, WASHINGTON.

THE

ENGINEERING MAGAZINE

VOL. IX. JULY, 1895. No. 4.

FIRST PRINCIPLES IN RAILROAD MANAGEMENT.

By Benjamin Reece.

WHEN we consider the existing social unrest, the vagaries of popular judgment, and the violent oscillations of political movements, we may well determine that for the past few years the first principles of government must have been grotesquely violated or ignored.

Whether we observe the financial, commercial, industrial, or moral development of the age, the same absence of equilibration is everywhere felt and observed. While the mechanic has proceeded with his marvelous triumphs over the material world, the statesman has proved his incapacity to properly conserve the industrial and social forces of our people.

Is it not inexplicable that the marked advance recently made in scientific discovery and mechanical invention should be attended with ebullitions of passion and unrest, threatening the integrity of existing social systems? The utter incoherence of political thought and expression, as made manifest in the declarations of party platforms, in the deliberations of radical clubs, and in the spasmodic appearance of the "Common Weal" and kindred bodies, gives proof of the bewildered state of the popular mind.

So deep-seated are these perturbations that no remedial scheme is too fantastic or absurd to find exponents and adherents, and unfortunately most of the political leaders who should give direction to the public thought are either abjectly silent or actively encouraging such vagaries, and, by giving apt and forcible expression to the existing prejudices of the voter, hope to receive the rewards of leadership and

Copyright, 1895, by the Engineering Magazine Company.

the emoluments of office without the labor of conscientious study and the exercise of the vigorous energy required to divert the flood-waters of popular error into the channels of wise and enlightened economic thought. Still another large portion of the community, reflecting the arguments presented and distrusting the methods proposed, are conscious of coming changes.

The complex and intricate relations which have arisen in the social group since the introduction of steam in the last century can hardly be comprehended, much less analyzed. The forces of production and distribution have been completely revolutionized. Machinery with its million workers has taken the place of the master workman, journeyman, and apprentice of a past age. Less than a century ago America was as far distant from Europe in point of time as in the days of Castilian glory; to-day, by railroads, telegraph lines, and ocean steamships, the communities of the earth are being gradually united into one commercial and interdependent whole. This tendency to union the politician has vainly sought to prevent by the substitution of artificial legislative barriers for the natural ones which the mechanic has overthrown. But all such effort must prove abortive, for the investments of idle capital in foreign lands, the further improvements and cheapening of transportation, and the greater enlightenment of the people are constantly checking the reactionary spirit which seeks to revive the isolation and provincialism of the period which preceded the use of steam. More and more is the political idea being outgrown. The attacks of predatory peoples are no longer feared, and invasions by foreign nations are too remote to be considered, except by those who look to the activities of war as a convenient escape from the social unrest and industrial turmoil which their legislative blunders have engendered.

The passions and animosities of men, which in preceding generations were directed against other tribes and States, are now directed against industrial groups. So the spirit of comradeship and loyalty which once united the members of the tribe and afterwards the State is gradually being transferred to the same industrial groups.

That the militant spirit in so marked a degree should continue to live and coexist with the highly differentiated industrial development of the age is in itself unaccountable, and can be explained only by the inference that the increased material possibilities of the age have not been accompanied with the corresponding moral restraints which that condition naturally imposes. On every hand we hear the breath of war and observe the manifestations of its spirit, and the growing temper and bitterness of industrial groups augur no good for the future of our development.

In the early days of the republic it was thought that our form of government and popular institutions were of themselves the guarantee of industrial peace and insured the happy contentment of our people. That illusion has passed away, and in no civilized country of the globe have the lines been more sharply drawn or the signs of impending conflict been more threatening. By physical force the employee has sought to control capital, and by the force which resides in wealth capital has attempted to coerce labor. Legislative majorities have imposed onerous and unjust restrictions upon railroads, and even political campaigns are directed to arouse the selfish instincts of the masses by special appeal and promise of laws affording advantages to the particular groups whose votes are sought. There is too little of that dispassionate discussion and intelligent inquiry as to measures of justice which will best conserve the interests of all.

Most of our laws in their essence are derived from those customs which came down to us from the feudal ages. Having their origin in an age of primitive nature and unsettled estates, they were, by environing conditions, measurably fitted for the early settlement and rapid development of our boundless western domain. The self-reliance, courage, migratory tendencies, and warlike energy of the early feudal group are seen again in the early western settler, who developed and exhibited the same traits, which he directed to the subjugation of nature in its boldest and wildest aspect. But no sooner had this settlement been accomplished and occupancy become complete than we found ourselves beset with the same social problems and industrial turmoils which the statesmen of Europe had so long labored to correct.

The feudal system was essentially founded on force. For the preservation of order in our early communities successive decisions of the courts, reinforced by statutes, have crystalized many of the old feudal forms into law.

It has frequently been the part of legislation to perpetuate disorder by preventing those movements and arresting those activities which are essential to social and economic readjustments.

As illustrating my meaning, let me relate a personal experience. While in Birmingham, Ala., during an active period of railroad construction some few years ago, I spent considerable time in the switching-yards, which were being reconstructed and enlarged. During one of these visits a track gang composed of negroes was directed to go and bring a frog for use in a turn-out. Six men equipped with three bars started to the store-yard, and I followed to see them work. After finding the frog of the required angle, the three bars were placed under the frog so that the six men could carry it by means of the extending ends of the bars. The rascals had evidently learned by experience that the further removed the load was from their end of the bar the less the burden they would be required to carry. So, after the bars were placed, the projecting ends of each bar were measured and equalized, awarding to each his fair share of the load. But no sooner had the frog been lifted from the ground than by a series of tugs and jerks each man sought to lengthen his end of the bar. Those who had lost ground in the contest refused to proceed further with the frog, and it was again lowered to the ground, and the ends of the bars were remeasured and readjusted, only to be disarranged as before. In theory these men were willing to be fair, but the temptation to gain the advantage was too much for them, and, after frequent repetitions of the scene described, consuming some ten minutes or more, the foreman appeared and with an oath commanded the men to move on quickly with the frog. So on they marched, each with the length of bar he happened to secure at the time the command was given. And the big strong fellow who had successfully jerked a goodly portion of the bar from his smaller partner in work on the other side of the frog strutted along with a light heart and a light load, grinning with satisfaction as he watched his partner tugging and groaning under his unequal burden.

Has not this been measurably true of many of our laws? Have not much of the unrest and discontent which we observe arisen from institutions which have grown up from the hasty and ill-advised settlement of social conditions by laws in which fairness and justice were sacrificed to secure prompt and enforced orderly action?

It is not to be supposed from what has been said that we have created and developed an industrial system which, as a people, we are morally unfitted to control. But it does imply that in the mighty changes which have been involved a certain freedom of experimental conduct must be permitted, so that the new relations will be properly discerned, thereby leading to normal re-adjustments.

As legislation has caused confusion by the repression of actions which it condemned, so has it caused equal disorder by stimulating activities which met with its approval. No sooner were the advantages of railroads fully understood than laws stimulating their construction were enacted in almost every State, and many of the existing evils in railroad management are traceable to the presence of such laws upon the statute-books. When the early roads had been united into continuous lines of commerce, there came the occupation of distinct territory. Then the invasion by the roads of each other's territory for the avowed purpose of dividing the traffic gave rise to rate-wars, which threatened the integrity of all railroad investments. When the disastrous results of this reciprocal rapine had been experienced, truce after truce was patched, only to be broken by the treachery of those who hoped to gain by craft and evasion what they had failed to secure by open war. After frequent intermittent struggles between the roads, the pool was organized, as affording a central source of power which would assign to each line its proper share of earnings. Meanwhile the shipping and travelling public had been educated through the means of these very wars to believe that in a multiplicity of lines rested the true basis of competition with low cost of service, and the pool, institstituted for the purpose of conserving great properties, was mistakenly regarded as the instrument of extortion and injustice. The effect was two-fold. Local aid was everywhere offered for the construction of competing lines, while pools and similar combinations were decried and ultimately prohibited by federal statute. It is worthy of note that the failure of the Inter-State Commerce Act to prevent discrimination by rebates and drawbacks has so modified popular opinion that a large majority of the State railroad commissioners, as well as the Inter-State Commerce Commission, have declared in favor of a modified pool ; and the last house of representatives passed such a measure, which failed in the senate only because it was not reached on the calendar before adjournment.

But unfortunately a restoration of the pool will not reach the cause of trouble. It will only correct the evil effects of an existing cause, and as such can only palliate and thereby make the cause more persistent in its operation. I refer to the loose laws which permit the construction of new railroads for the profits arising from construction and the marketing of securities.

The public clamor for more railroads is predicated on the assumption that a multiplicity of lines intensifies competition and tends to lower the cost of service. And yet it stands to reason that any increase of lines in excess of the requirements must ultimately increase the cost of transportation, by compelling the maintenance and operation of more lines than the business warrants.

That a healthy and prosperous condition of a community is not dependent upon the existence of competing lines of railroad is well attested by the case of Connecticut, which is almost solely dependent upon the New York, New Haven and Hartford Railroad for its transportation. While practically monopolizing the business of the State, this road has spent millions of dollars in the improvement of its line and the bridging of highways to secure the public safety. Its passenger service in the number and average speed of trains is unexcelled, while the rate of passage is less than 1¾ cents per mile. The activity and growth of its many flourishing towns are convincing proofs of the utility and cheapness of the freight service, and with all this the section laborers receive exceptionally good wages, while 10 per cent. annual dividends to the investors have been the rule. That lines having similar advantages of position have used them unwisely for purposes of extortion is also true,—with the resultant construction of competing lines to lower the rates and divide the traffic.

The principles of justice and fair dealing, when fairly understood, operate as an irresistible force in the guidance of the public conscience, and, when we note the gradual subsidence of the bitter prejudices against pooling, it must be clear that a better realization by the people of the evils of over-construction will soon remove that danger.

The civil engineer, in building his bridge, knows that in providing for his strains every pull involves a push and every push a pull, and thus, through the means of stress, rods, and chords, the numerous members act together, and safely bear the loads they are required to carry. Here then is suggested the true basis of enlightened railroad management founded on justice. It is no more and no less than the equilibration of conflicting interests.

The railroad manager during the war was the pushing, driving organizer. When the panic of 1873 came, a new danger arose, and new qualities of management involving financial ability were brought into requisition. With the present dangers, including hostile legislation, a distrusting public, and restless employees, still higher qualities are required. The manager of the future must learn that success depends upon the prosperity of the communities it serves, and that to charge unduly for services performed must react in decreasing business, which in its logical results means eventual dissolution. Likewise in dealing with employees. Good men are not averse to strict discipline, *if justice is observed;* but the effect of ill-considered and capricious judgment is demoralizing in the extreme. The tendency of the day shows that the true relations existing between the railroads and their employees are being earnestly studied, with the prospects of a better understanding.

The railroad problem is to be solved by the maintenance of good faith between the railroads themselves, by the growth of reciprocal feelings of good-will between railroad and patrons, and by the restoration of mutual confidence and dependence between it and its employees. Each relation is a dual one, and can be arrived at only by a recognition of the interdependent relations. Failing in this, order will eventually be restored through the bitter experiences and waste of opposing and counteracting forces, which, if working in harmony, would conserve the prosperity of all.

THE LEGISLATIVE REGULATION OF RAILROADS.

By Albert Fink.

BEFORE the present Inter-State Commerce law was enacted, some of the more stringent provisions originally contained in it were materially modified. In fact, there is every reason to believe that, without such modification, the law not only would have proved utterly ineffective, but would have inflicted incalculable injury upon all the commercial interests of the United States. That such beneficial changes were made in the legislation originally contemplated is generally admitted to have been due to the educational campaign conducted by Mr. Albert Fink, who on a number of different occasions appeared before committees of congress and other public bodies with a vigorous and convincing exposition of the nature and operation of the unwritten but all-powerful natural laws which determine the tariffs, methods, and policies of the transportation companies of all the world. No more important contribution to the solution of the railroad problem has heretofore been made, or is likely to be made hereafter, than that which may be gleaned from the arguments and expert testimony of Mr. Fink, as contained in the reports of these congressional hearings, and from his occasional contributions to the journals of the time. The extracts hereinafter presented have been carefully selected from these sources, and, so far as practicable, have been arranged to present a coherent and consecutive argument. The striking accuracy with which many of the predictions of Mr. Fink have been fulfilled in the progress of events during the eight years and more in which the Inter-State Commerce act has been the law of the land would seem to render the republication of his observations a matter of more than ordinary interest and importance at the present time.—THE EDITOR.

It is first necessary to clearly understand what are the evils to be remedied. It will be found that the complaints of the public are directed against the commercial management of the railroads,—the charges made for transportation service, or the adjustment of the railroad tariffs. We hear of no public complaint against the technical management of the roads ; and it may be said with some pride that, as regards the accommodations and facilities furnished to the American people,—the safe and prompt and economical conduct of the passenger and freight traffic,—the management of the railroads in this country is superior to, or, to say the least, not surpassed by, that in any other country. A passenger may traverse the continent, almost enjoying the comforts of a home. Freight is being shipped from and to the remotest parts of the continent with great expedition, and without subjecting the shipper to the many annoyances and inconveniences which are experienced in other countries. These results have been secured partly through the consolidation of a number of roads into long lines, or large systems under one control, or through the coöperation of the many yet existing separate railroad companies, by which unity of management, so necessary for the proper transaction of business, has been practically secured.

The solution of the railroad problem in this country is, therefore, confined to the satisfactory settlement of the question of tariffs, and may be said to consist in the attainment of the following objects :

(1) To establish a reasonable and equitable railroad transportation tariff for the whole country.

(2) To maintain this tariff with the greatest possible degree of permanency.

I purposely state the problem under these two separate heads, in order to simplify its consideration.

The solution of the first part of the problem involves the consideration of this question : "What is a reasonable, equitable, and justly discriminating railroad tariff?" It is held by some that a tariff, in order to be reasonable, must be made in exact proportion to the cost of the service performed ; but then the question arises : "What is the cost?" and this is a very difficult question to answer. In some instances the cost of transporting one ton of freight one mile may only be 1-10 cent, and at the same time, on the same road under different conditions, it may be 10 cents or more. To make even an approximate estimate of the cost in any given case is a work of great difficulty and complexity, and strictly to comply with the condition that a railroad tariff, in order to be reasonable, must be based upon actual cost, and made in exact proportion to cost, is an impossibility.

It is equally difficult to answer the question : "What constitutes just and unjust discrimination?" It is conceded that discrimination in transportation charges must be made ; but when are such discriminations just, and when unjust? In order to ascertain this we may apply this test : a tariff is just when, under its operation, one shipper is not injured at the expense of another, and when like charges are made for like services. It would, however, be vain to search for one general principle applicable to all cases that occur in daily practice, according to which we could, *à priori*, decide whether a railroad tariff complies with these conditions or not.

For example, a railroad company may charge twice as much to one shipper as to another for the same kind of goods shipped from the same point to the same destination; yet this in itself is not proof of unjust discrimination, as the quantity shipped by one may be comparatively small, and the actual cost of carrying the smaller quantity may be twice as much per 100 lbs. as that of carrying the larger quantity. The value of the articles to be transported, and their prices in the different markets in which such articles are to be exchanged, determine most frequently the transportation charges, regardless of the cost to the carrier or distance to which the articles are to be carried. So long as there is any profit at all to a railroad company in moving certain articles of commerce, no matter how small that profit may be, —to meet competition either of markets or of other transportation lines,—railroad companies should not be obliged to refuse to carry such low-priced freight, because they cannot afford to do the whole of their business at so small a profit. They must be allowed to make greater charges on articles which can bear higher rates of transportation, and disregard the principle that charges should be in exact proportion to cost.

Either they must do this, or the articles which do not stand the higher charges of transportation cannot be moved at all, and the profit which could have been derived from their carriage would most likely be replaced by a further increase in the charges on those articles which can stand higher rates. In all the business transactions of a common carrier, as well as in all other commercial transactions, the laws of trade and commerce, of demand and supply, ought to be allowed to have their full influence; and hence they must have a most important bearing upon the construction of railroad tariffs. If these laws were disregarded, it would soon be discovered that railroads could not be operated at all, or that their usefulness to the public and to their owners would be immensely curtailed. Now, as railroads were not built for the mere purpose of carrying out abstract principles, but for the purpose of making them subservient to the wants of the people, facilitating trade and commerce, and developing the resources of the country, it follows that the great commercial principles—those that give existence and life to the roads—become paramount, and that the "pro rata principle," or the "cost principle," can be applied, if at all, only in so far as it does not come in conflict with the recognized laws of trade and commerce.

From these considerations it will appear that transportation tariffs cannot be established by simple arithmetical or mathematical rules; they require the application of a number of principles, all correct in themselves, to a great variety of ever-changing facts. This is neces sarily the work of experts, and not the work of legislative departments of government. All attempts to lay down specific rules for the regulation of tariff have heretofore failed.

To protect the people against extortion or unjust discrimination of common carriers, you cannot devise or formulate a more precise and definite law than the common law, which embodies the experience and wisdom of past ages, and which, I am convinced, cannot be improved. It guarantees to the people reasonable and just rates of transportation, and necessarily leaves to the courts to decide what constitutes reasonable and just transportation charges. These are questions that can be decided only after a full consideration of all the facts controlling each case.

Owing to the commercial nature of the transportation business, the laws of trade and commerce, which should govern the management of that business, come, under certain circumstances, in direct conflict with the duties of the common carriers as public servants. The spirit embodied in the common law can be put into practical execution only by restricting or regulating, to a certain degree, the operation of the commercial laws,—the law of competition, as applied to the business of the common carriers themselves. It cannot be expected that a number of public servants, when engaged in competitive struggles with each other,—in other words, when engaged in a free fight,—could perform their public duty as common carriers, and guarantee equal and just rates of transportation to all shippers. Such guarantee can be given only when these public servants are made to act in concert in all matters relating to their public duty,—the establishment and maintenance of reasonable and just transportation tariffs. But, if the public prefers that the laws of competition should remain in full force as between these public servants, it must dispense with the enforcement of the law regulating common carriers, and be satisfied to endure the evils which result from the violation of this law,—*viz.*, unjust discrimination, and constant fluctuations in the transportation charges.

The difficulties do not arise from the fact that there are not properly any well-considered and satisfactory tariffs of transportation for the Inter-State traffic of the country, but from the fact that these tariffs are, in most cases, utterly useless, because they are not carried into practical execution. They are often disregarded almost as soon as made. Each company may change or abolish them at pleasure; and from this state of affairs result all the evils of the transportation business,—the general confusion in transportation rates, unequal charges to shippers at the same locality, unjustly discriminating rates between different localities, uncertain and constant fluctuations in the transportation rates. If therefore, it be desired to remove these evils, it becomes necessary to consider first the causes which prevent adherence to the proper and just tariffs; and the question has to be answered: Why are the proper tariffs not enforced?

Simply because there is no authority in this country, no power to enforce them. Each railroad company is at liberty to deviate from the established tariff whenever it pleases, although it may have voluntarily given its consent to it and agreed to maintain it; any one of the companies may, and frequently does, enter into secret arrangements with shippers, and reduce the rates, in the hope of procuring a larger amount of business than it otherwise could obtain, or of securing some other advantage over its competitors. No sooner is it discovered that one company engages in this practice than the others must and do follow. No sooner has the tariff in any one city been disturbed than the tariff in other places must necessarily also be disregarded. Owing to the mutual dependence of tariffs,—a feature of the transportation business to which I shall more particularly refer hereafter,—a change at one important point must be followed by a general readjustment throughout the whole country, or through a large section of the country.

Under the process of underbidding, heretofore so generally practised by competing railroad companies,—a practice always encouraged by the shippers, and incorrectly called competition,—no just and equitable tariff can be maintained. I say competition is not a correct name, because legitimate competition can always be carried on openly and above board; the process here described, when competitors are under an agreement to maintain the same tariff, is simply a process of cheating and deceiving, and ought not to be dignified by the name of competition.

The rates at local points are under the control of a single railroad company, while at competitive points they are not controlled or controllable by any one company. The proper and established tariff can only be maintained by the railroad companies acting collectively, as one party. In the absence of this necessary coöperation between all the companies which are in a position to influence, change, or altogether annul such tariffs, the abandonment of the best-regulated tariffs, is unavoidable; and, without their strict maintenance, chaos and unjust discrimination must reign supreme.

No provision is made in this bill looking to coöperation between railroad companies, as a necessary condition toward the attainment of its object. It not only does not authorize such coöperation, but, strange to say, it actually forbids all combinations between railroads by which they have heretofore been enabled to maintain at least some degree of system and order in the conduct of the transportation business. Moreover, this bill is to do away with the good that has already been accomplished, and to send us back into the chaos from which we are just now emerging. It professes to undertake the prevention of unjust discrimination, and yet it says to the railroad companies: you are forbidden by authority of law to take the proper and necessary steps to obviate and remove this unjust discrimination.

All legislation for the past 40 years on the subject of railroad tariffs has been futile, because legislators have failed to comprehend and to recognize the true nature of the subject with which they attempted to deal. They have directed their laws to the suppression of the outward symptoms of the disease, instead of to its cause. The true cause of the evils to be remedied lies in the separate action of a great number of independent competing roads, no one of which, by its single efforts, can remove the evils. Any legislation, to be effective and successful, must deal with the system of railroads as a whole; in other words, it must look to the combination of all the roads, so as to make them, in effect, act as one road, so far as their duty as public servants requires them to maintain just and equitable rates of transportation, and prevent unjust discrimination.

The railroad companies have endeavored to secure unity of action by voluntary coöperation in all matters in which it is absolutely necessary for the proper management of the roads, in the interest of the public, as well as in the interests of the proprietors of the roads. But this coöperation has been most inefficient in all matters relating to the uniformity, equality, and permanency of railroad tariffs, although in other respects, as already mentioned, it has been very successful.

It is on account of the great complexity of the tariff problem that this voluntary coöperation has not met with better success, and not for want of effort or desire on the part of the railroad companies to control it; although the public, ignorant of all the difficulties to be overcome, presume to hold each separate road responsible for the working of the whole system. The difficulty, however, has been not so much in agreeing upon the proper tariffs as in carrying them into practical effect. The necessary means and machinery for that purpose have not been adopted, and there is no authority to enforce such agreements.

The managers of roads meet in convention, and make agreements which are broken before they disperse. Every one who has paid the least attention to this subject is familiar with these unsuccessful efforts. The press of the country chronicles almost daily some conference held by officers of railroad companies, or some agreement made, and on the following day it chronicles its violation or discontinuance.

During the last few years, however, some progress has been made toward a closer and more effective coöperation. Associations of railroad companies have been formed, with a proper organization, through which it was made at least possible to control the important tariff question. I do not mean to say that perfection has been reached in this respect, because much remains to be done; but cases of violation of the tariff rates, as far as the trunk lines can exercise their influence, are now the exception, and not, as heretofore, the rule. In my judgment, the only measure now wanted in order to give permanency to the operations of these associations is recognition of the same as necessary and beneficial, giving legal force to the voluntary agreements between its members, with the view of carrying out the objects of the association,—namely, the establishment and maintenance of reasonable and non-discriminating transportation tariffs. If congress would pass a law to this effect, I would consider the whole railroad problem in this country settled, and upon truly American principles. It would allow the proprietors of the railroads to manage their own affairs, which they are much better able to do than a centralized government would be, and at the same time it would restrict the operation of each individual road under the legalized coöperative system to the extent necessary in order to carry out the intent of the law which regulates the conduct of common carriers in their capacity as public servants.

I am aware that objections will be raised to the proposed plan on the ground that it will restrict competition. It will, of course, be impossible to adopt any remedy that would do away with unjust discriminations and fluctuating rates, without restricting at the same time, to a certain degree, the strife—but not the competition—between railroad companies. It is just as impossible that the unrestricted strife between railroads, improperly called competition, could be continued, and at the same time equitable, permanent, and discriminating rates of railroad transportation could be secured to the public, as it is to mingle fire and water into a homogeneous mass. The existence of one excludes the existence of the other. It is either strife between these common carriers—or public servants—and all its attendant evils, such as unjust discriminations and fluctuating rates; or it is coöperation and unity of action in all matters relating to the competitive tariffs, resulting in permanent, just, and equitable rates. The people will have to choose between the two. Each of these plans has its advantages and disadvantages. In this, as in all other human affairs, perfection is not possible, and the question simply is: Which is the lesser of the two evils? It would be a comparatively easy matter to establish proper transportation tariffs, if each separate carrier could make its own without regard to others,—a condition of things which is generally supposed by the public to exist. The fact, however, is that only upon a very small portion of its traffic can a railroad company control its tariffs.

The competitive railroad tariffs for Inter-State commerce are not, as is so generally supposed, under the absolute control of railroad managers; the carriers by water routes really establish these tariffs, and the railroad managers have nothing to do but conform to them. The water routes not only control the tariffs of their immediate rail competitors at points where they can render like service to the same people, but their influence reaches, directly and indirectly, to the remotest parts of the country. Compared with this natural powerful regulator of railroad transportation tariffs, the efforts of State or congressional legislation to prevent extortionate charges appear to those who are fully conversant with the subject as perfectly useless; and the declamations against the baneful effect of the so-called railroad combinations appear simply as idle talk.

While the water routes exist only between Chicago and New York, the effect upon transportation rates is felt all over the country, by reason of the competition between the railroads. No combination of the railroads can suppress this competition. It could only be done if the railroads were all owned by one party, and were operated in one interest. But, as it is, they all have separate interests, and each one, in guarding its own, keeps up this competition; and the rates, even when agreed upon between themselves, are fixed by competition. This, unfortunately, is not understood by the public. It is generally believed that, when competing railroads agree upon uniform rates, this excludes competition. This is not the fact. The effect of water competition is felt not only east of the Mississippi and Ohio rivers, but south of the Ohio river. For example, the low rates from Louisville, under the influence of the Chicago low rate, is felt in Memphis, Nashville, and further south. Freight from Memphis is shipped to Louisville and gets a low rate from there, and the people of Nashville and such places get as much advantage from the low rates as if really located on a water-course; so that the influence of the water transportation is felt almost throughout the whole country. That is the influence of the Erie canal. To the south there is the water route from New York to New Orleans *via* the ocean, and from New Orleans freight is carried to Memphis and Saint Louis and the West *via* the Mississippi. In order to meet these low rates, the east and west roads from Louisville and Memphis, or from Memphis to Norfolk east, have to conform again to the low rates made by the Atlantic ocean and the Mississippi river. In this way the water-courses are really regulating the railroad transportation rates throughout, one may say, the whole country. Rates generally are higher west of the Mississippi, but the people west of the river get the benefit of the low rates east. In many other ways the water-routes help. The Ohio river, the Tennessee river, and the Cumberland river affect the railroad rates at the interior. There is plenty of competition that regulates the rates and keeps them at an exceedingly low figure. Not only do the water-ways control the rates,—narrowly limiting them, at any rate,—but the competition of the markets for the products that are to be carried is another great factor in fixing railroad transportation rates. The price of carrying grain, for example, is fixed not by the railroad companies, but in the markets of the world. That price is generally regulated now by the Liverpool market, and, if railroads want to carry any grain, they have to carry it at a price that will enable the producers to compete in the Liverpool market with the markets of the world. So widespread is the influence of competition that the charges for transportation in East India have even become factors in making railroad rates from Chicago to New York. There is no danger whatever of any excessive charge.

It can be shown that the transportation charges on almost every article of consumption are limited by commercial conditions. Many cheap articles, such as coal and iron and lumber, have to be transported at a very low rate, if they are to be transferred at all. The tariff is fixed by the market price of the products in the different sections of the country. The railroad transportation charges can never be more than the difference between the market values of the articles in different markets which determine for the railroad companies their charges in a great measure ; and therefore there is no necessity for any arbitrary legislation on the subject.

Some time ago I received a communication from a firm in New York, largely engaged in the stave and cooperage business, representing that it is making efforts to extend its business to Europe, and to place these products in the English markets in competition with those now brought to England from Norway. This firm applies to the railroad companies for lower transportation rates than are at present charged upon those articles when carried to New York for domestic consumption. The present rates to New York are perfectly satisfactory to them, and to the trade generally, as they ought to be, being but 6-10 of a cent per ton per mile,—not much more than the actual cash cost of the service,—but it is alleged that without further reduction it would be impossible to compete in the English market with the Norwegian products.

In order to encourage industry and commerce, and enable the people of America to enter into competition in foreign markets, the railroad companies might be perfectly willing to carry such freight destined for export at still lower rates, or even at the net cost, without profit. They frequently do so to meet home competition in distant markets, or to aid in the development of the country. But it would be impossible for the railroad companies to carry the whole of their business at such low rates, or at the mere cash cost, leaving nothing for profit or interest on capital invested. Under the "Reagan Bill" the railroad companies are to charge as much for the export as for the domestic business,—for like service the same rates,—thereby prohibiting the railroads from giving to the commerce of this country that aid which otherwise they would be able to offer, and thus preventing the building up of new industries that might result to the great advantage of the people.

In my opinion, it is utterly impossible to formulate a law defining just and unjust discrimination. Any act is just in commercial transactions and in railroad management which does no injury and benefits all concerned. If it can be shown, as I believe it can, that nobody suffers from the fact that the railroads carry freight more cheaply over long than over short distances, the carriage of such freight is just and proper, and, being also beneficial to the commerce of the country, it should rather commend itself to the favorable judgment of legislators than be made a misdemeanor, punishable by fine.

Wherein does the injustice consist if the railroad companies carry freight intended for export to New York at lower rates than if intended for domestic consumption, as long as the charges for the latter are reasonable? It is certainly not unjust to the people in the West to create for them a market for their products. It certainly is not unjust to the merchants of this country who derive some profit from this trade. It certainly is not unjust to the American people that the English people should contribute to the wealth of this country by the purchase of these products. It certainly is not unjust to the railroad companies that they should increase their business, even at a small profit. It certainly is not unjust to the domestic consumer of the article in New York, who pays a higher price of transportation for it than the exporter; because, whether the railroad companies do or do not engage in the export business, the rates of transportation to the domestic consumer, reasonable as they are, remain unchanged. If the feelings of the domestic consumer are hurt because the exporter gets lower rates of transportion, he can console himself by the reflection that the foreign consumer has to pay the ocean freight in addition to the inland freight, making the total cost to him much higher than to the American consumer. To carry freight at a lower rate for the exporter than for the domestic consumer is, therefore, not unjust, since it is beneficial to all engaged in the transaction; *it* hurts no one; the only disadvantage is to the foreign competitors,—in this case, the people of Norway. Is it the duty of congress to protect foreign nations against American competition?

Chicago is the regulator of the rates throughout the whole country, on account of its command of water transportation. The roads carrying freight from Chicago to the east have now an understanding, according to which each one agrees to be satisfied with a certain proportion of the total business from Chicago, and each one pledges itself not to pay rebates or secretly lower its rates in order to secure more than the proportion agreed upon. There is, of course, no objection to any one of the roads reducing its rates openly, if it chooses to do so, for then the other roads can make similar reductions; but it is agreed that these reductions, if any are to be made, shall not be made secretly, in order that one shipper or one railroad may not have an advantage over the other. An agreement of this nature has been incorrectly called "pooling." But you will observe that this agreement is made exactly for the purpose of carrying out the object of the Reagan bill, which is to prevent the payment of rebates, and thereby prevent unjust discrimination. The true nature and object of agreements of this kind are little understood; otherwise it is to be supposed that the prohibition of the only practical measure by which they can be realized would not have been made. This inconsistency is probably due to the misleading word "pooling," which, being a gambling term, has not the least application to the process to which it is applied.

It is a mistaken idea that these arrangements are compacts for the purpose of preventing competition, and it is upon this erroneous view that the objections are based. These agreements to divide the traffic between competing roads are changeable, according to the interest of the parties to the agreement. If one or the other railroad company improves its facilities of transportation, or improves its connections, and thinks it is entitled to carry a larger share of the traffic than it has been allowed in a division, it calls for a revision of the compact, and a readjustment must be made according to the merits of each line. In this way the spirit of competition is kept alive; each road continues to strive to secure the largest patronage; but, instead of doing so by paying rebates and by violating the laws of common carriers, it has to use open and legitimate means of competition.

The objections to the so-called "pooling" process are, therefore, based upon an entire misapprehension of its nature and of its good effects. It possesses the great advantage over absolute consolidation of railroad property—which is not considered illegal or against public policy—that it keeps up the spirit of competition, while at the same time it secures the advantage of absolute consolidation,—unity of management. When private parties cannot agree on questions that may lead to dissension and quarrels, they are obliged to submit them to the adjudication of properly-constituted courts. They are not allowed to involve their neighbors in their quarrels; they are not permitted to set their own houses on fire to spite each other, and destroy the property of their innocent neighbors. And why should not the same restrictions of the law be applied to warring railroad companies, whose action and whose management involve such large public interests, and who are really the creatures and the servants of the public?

It is time that the antiquated notion that has taken such a strong hold of the legal minds of the country—the notion that all agreements between railroad companies, in regard to transportation tariffs, are against public policy, and are in the nature of conspiracies—should at last give way to a proper understanding of the true nature and objects of these agreements, and to a conviction of their necessity and of their highly beneficial results: and, instead of prohibiting such agreements, the government should give them legal force and should exercise its power in carrying them out. That is all that is required on the part of congress in order to settle this vexatious railroad problem.

REFORMS IN RAILROAD MANAGEMENT.

By Henry Clews.

THAT radical reforms are required in railroad management is a postulate that hardly anybody will controvert. If you should put the proposition in the form of a question to the various classes of reformers, from the president of a trunk-line system down to the political leader, Populist leader, free-silver leader, tariff-reformer, and Anarchist destructionist, all would answer "Yes" in the most emphatic tone. But from that affirmative point there would be an important divergence of opinion. Now, the problem in railroad management is to find a point of convergence at which these various opinions can be successfully focussed, with the exception of the views of the Anarchist. It is necessary to leave him out, if the others are to be retained.

These people are all elements of our body politic, and in a great question which affects the entire community they have a right to be consulted. Now, while it is impossible to satisfy all of them, and while majorities rule, it seems to me that a plan which would confer the greatest good on the greatest number should obtain a majority vote on a fair count. Railroads, if honestly and prudently managed, are capable of conferring the greatest possible commercial and social benefits upon the community and upon the human race, and they should therefore be managed in the interest of the whole people, but not by the government. This would at the very outset spoil the scheme of consulting all the diverse opinions to which I have referred. While parties are so clearly defined in our political system as Democrats and Republicans, there can be no safe government ownership of railroads in this country. In order that railroads may attain that degree of expansion and usefulness which is their inherent promise, they must be placed on a basis of stability, not liable to be shaken up every four years. Under government control there could be no well-laid schemes for the constant and uninterrupted development of the whole system and its progressive improvement. The quadrennial interruption of politics, and the numerous rivalries and jealousies inseparably connected therewith, would, in my opinion, play havoc with all the economic and industrial advantages—though they are many—capable of being derived from a grand central and bureaucratic system of government management. It may do well enough for Germany, where the military idea is predominant and the protective and defensive system of the country may require it; but the people of this Republic would cut a sorry figure, I fear, in the leading-strings of paternalism, after the freedom with which they have become familiar, and government ownership of railroads here would play anarchism with Wall street securities. It would possess most of the bad features of the close corporation, and few of the good ones. It would at least be unwise to experiment with a government scheme until all hopes of reform in other directions had failed. Let that be the last resort.

Yet, if some plan is not put in operation to subserve the interests of shareholders, and protect them from the avaricious encroachments of managers, government aid may be called for as a forlorn hope; but I am still hopeful that means will be found of averting this calamity. I think a protective system of committees, chosen by the stockholders of every railroad, to investigate the management and have its accounts audited periodically by trustworthy experts, upon a plan that would exclude the possibility of collusion,—the reports of these committees to be submitted to a central association, also chosen by said stockholders, at reasonable intervals,—would reform, and, in time, thoroughly eradicate, most of the evils now complained of, and make the railroads the most potent instruments in developing our material prosperity, through our unlimited resources. There is a plan of this kind now in course of development, but not yet far enough advanced for a full description. It will, I believe, do more to solve the vexed problem of managerial integrity and capability than any of the previous devices, many of which have been very fair tentative schemes, but all of which have been lacking in breadth of purpose and general applicability of design.

The period succeeding the last panic has exposed more weak spots in railroad management, probably, than any former period. Matters seem to have been tending towards a culminating point during the past few years. The management has in too many instances been directed towards sustaining the market value of the securities, instead of building up the intrinsic value of the property. Borrowing money, at the expense of the property, to pay unearned dividends has played an important *rôle* in the operation of creating fictitious values, which have often acted like a boomerang and demoralized the speculative market. This system is entirely vicious, and will have no place in the reformed management proposed, by which the public in general will have ample means of discovering the true value of every railroad property. The veil of secrecy which has hitherto concealed so many rotten schemes, so fruitful of bankruptcies, defalcations, and panics, will be torn away, and the financial status of every property laid bare to public view and open inspection.

Of course, it will require some legislation to accomplish all this, and it must be of a more comprehensive character, and more popular and beneficent in its outcome, than the Inter-State Commerce Law. The clause against pooling in that act must be repealed, and perhaps it may be necessary to recast the whole measure. I do not mean to disparage the legislators in whose brains the law originated, for I recognize the impossibility of foreseeing all the necessities that may arise in human concerns; but several years' bitter experience of the law in question has left no room for doubt of its inadequacy.

This law seems destined to cause endless trouble and expense wherever it comes in conflict with the State laws, and to this it is constantly liable. A case in point came up in the supreme court of the United States a few weeks ago from the Milam county court of Texas, reported in the *Railway Age*; it illustrates some of the great difficulties connected with making railway rates, and the perplexities with which freight agents have often to contend. The case, leaving out legal verbiage, was briefly as follows: The Gulf, Colorado and Santa Fé railroad was plaintiff in error against J. D. Hefley. A firm in St. Louis had shipped to Hefley and his partner, who were merchants in Cameron, furniture by the St. Louis & San Francisco railroad. The bill of lading showed that the freight charges were at the rate of 69 cents per 100 lbs., the whole bill being $82.80. Hefley presented the bill of lading, and made a tender of the money, which the railroad agent refused, not having been informed that the rate had been changed from 84 to 69 cents. He also refused to deliver the furniture. The agent was in this dilemma. If he refused to deliver the furniture on tender of freight charges, his company was liable for $82.80 for each day of delay, according to the law of Texas. If he did deliver it before the change in the rate had been posted up 3 days, the company would be liable to a fine of $5,000, according to the Inter-State law. So the agent prudently chose the less evil in refusing delivery. Hefley sued under the State law, and recovered his $82.80 for one day's delay; but the company appealed, and Judge Brewer reversed the decision of the court below on the ground that the State law, in a case of conflict, must yield to the national law as laid down in the constitution of the United States, which says in Article 6: "This constitution, and the laws of the United States which are made in pursuance thereof, shall be the supreme law of the land."

Now, here is a clear case, and a recent one, in which a railroad company has been enabled to take advantage of its own negligence, or the negligence of the company with which it connects, or both, to perpetrate a manifest injustice upon a merchant. If the notice of the change in freight rates had been posted up according to the requirements of the Inter-State law, of course the trouble would have been avoided ; but this only goes to show that a difficulty arising from the slightest omission in a simple detail of what this law requires, which a common-sense agent, without any education, legal or otherwise, could settle equitably in five minutes with any consignee of like common sense, may involve long and costly litigation to all parties. And it also shows that, even if the law were strictly conformed to in all its petty details, it still affords a large margin for vexatious and expensive delay, both to shippers and railroad companies. In the very case cited, the freight agent could not have acted, on pain of penalty to his company, unless the rate in question had been posted up 3 days, and, if an increased rate, 10 days. Everything relating to these notices was, of course, studied in advance by the most profound legislative minds, before the Inter-State law was enacted ; but still the law will not stand the test in practice, when applied to the most ordinary transactions in shipping, which shows that the aftersight of the most illiterate shipper is better than the foresight of some of the most eminent legislators. This is humiliating for the legislator, but it is impossible to evade palpable and stubborn facts.

Secrecy seems to be largely at the bottom of bad management. If our national legislators, instead of attempting legislation designed to regulate rates and internal management, as exemplified in some of the abortive provisions of the Inter-State Commerce Act, would profit by the experience of Massachusetts, they would substitute for the Inter-State Commerce law, a general enactment requiring, under heavy penalties, the utmost publicity in official reports of railroad affairs.

The history of the Massachusetts Railroad Commission, which was first organized in 1869, shows what intelligent public opinion, properly directed, can do in reforming the abuses of corporations. It was at first an experiment on the part of Charles Francis Adams and a few other men of advanced thought and large experience. It was the means of bringing about reduction in rates in a very satisfactory manner to all interests concerned, and without very much friction. Its powers were gradually enlarged without becoming oppressive, and it has done more, perhaps, to solve the problem of so operating railroads as to meet the wants of the various industries and commercial interests of the State, while conserving the best interests of the stockholders and investors, than any other scheme that has been tried. The main object of the commission was, in brief, to discover how the roads could best be made to promote the interests of the State, and its history shows that great success has been achieved in this direction. The uniform system of auditing accounts, adopted by the commission, —a system to which all corporations were required to conform,—was one of its best features, and it was singularly successful in the introduction of this system in adjoining States. In this respect it seems to have been the " little leaven " that may yet " leaven the whole lump." Let us hope so.

One railroad magnate, Mr. C. P. Huntington, thinks that consolidation is the remedy, carrying this idea so far, in fact, as to favor making all the railroads one great trust, or not more than three consolidations in all at the very outside ; he believes that one would be best. Such a trust as he imagines would undoubtedly greatly cheapen the cost to both producers and consumers, as he argues ; but it would require ironclad legislation, strictly administered, to regulate a trust of such unprecedented magnitude and potency as Mr. Huntington approves. It would be nationalizing the management of the railroads, after all, but in a slightly roundabout fashion. " Of two evils choose the less " is a good and durable, though trite, adage ; but which of the evils would be the greater in this case is, I think, problematic,—a big trust that would conduct the carrying-trade of the nation, or a government that would do the same thing. I think it would be bad policy to risk either at the present stage of our social development.

It seems evident to me that either this plan of Mr. Huntington's or government ownership would destroy competition ; this would be against public policy, and would eventually destroy healthy speculation and investment, first bringing these operations to a general condition of stagnation. All other business, in my opinion, would suffer in sympathy, and we should recede to a state of inactive, semi-Oriental barbarism.

Consolidation on a large scale, destroying competition, would deprive railroad management of that pride of emulation for which there would remain no motive, and which is one of the most potent causes of the great efficiency of the roads as carriers, and of their progress towards a still higher standard of efficiency. A government of, for, and by the stockholders, having their protective committees duly elected and organized to carry out their wishes and to report all delinquencies on the part of officials, as well as deficiencies in management, and all loose and negligent methods inconsistent with the best interests of the security-holders, seems to me to be the panacea, if there is any, for the railroad troubles. Under a system administered in this way, we should not have that unhappy state of things which Dr. Chauncey M. Depew post-prandially deplores,—namely, " when railway officers and employees are separated from their fellow-citizens of other pursuits, and relegated to the unhappy position of doubtful persons in a community." It is greatly to be regretted that the country should have to suffer the loss of Mr. Depew's failure to reach the executive chair in the White House, simply on account of those business connections for which he is by no means to blame, and over which he has had hitherto hardly any more control than he had over the circumstance of having been born in Peekskill. But there are some unfinished suggestions in that Detroit speech recently delivered. Take the following specimen, for instance: "The railroad is an expression of commerce, and the iron rails interlacing and intertwining through the States are bonds of union. . . . This internal commerce of the United States makes our country the most wonderful market this globe has ever known. It is the breath of our national life. With it in prosperous condition, we can successfully compete in the markets of the world." It strikes me forcibly, then, that it is of the first importance that this "breath of our national life" should not be stifled by any methods of suffocation such as those employed by railroad managers who organize stock-jobbing schemes in their own securities and become railroad wreckers. These throttlers should themselves be asphyxiated, and General Depew is one of the heroes best qualified to lead a successful charge against these enemies of our national life and prosperity.

It is clear to me, after looking over the railroad situation, especially with regard to the intrinsic value of railroad securities, that, if our great railroad system is to escape the petrifying enslavement of national ownership on the one hand, and the evils of consolidated monopoly on the other, the most effective means of assuring this escape is so to administer the operations of the roads that their securities will command the confidence of the greatest possible number of investors, both large and small. The panic of 1893 afforded a stupendous object-lesson as to what is pretty certain to happen when investors begin to lose confidence. While business is prosperous, the weak places in railroad properties are hidden from public sight, often in the glare of speculative success. This is the case now, to some extent. But, when trouble assails, failures begin, and money becomes stringent, then the weak spots become rotten and the bad and fraudulent management is exposed, the consequences being panic and disaster. What happened in this country to railroad properties in 1893 is happening daily all over the world to business men who foolishly betray the confidence reposed in them by partners, stockholders, and bankers, and the fact is patent to any one who will look over the list of stock-exchange securities and compare the present with the past that the properties which weathered the panic of 1893 were, with few exceptions, those that have been characterized by sterling honesty and the utmost publicity in their managment. The history of those that got into trouble has been partly written, but the most interesting chapter has yet to be brought to light. It will furnish a startling contrast to the history of the prosperous securities, but the time may not yet be ripe for a full exposé.

We have at present among our railroads some eminent illustrations which demonstrate that properties honestly and capably managed have steadily risen in value. Among these may be named the Vanderbilt systems, the Pennsylvania system, the Rock Island, Illinois Central, Delaware and Lackawanna, Delaware and Hudson Canal, some of the Grangers, and a few others. I could name a number in the opposite category, but do not wish to make invidious distinctions. Some of the latter are likely to fall in line with the new era of reform, and may largely retrieve past delinquencies.

It is amazing to contemplate the great prosperity that our railroads are capable of conferring upon the country under efficient and honest management. In spite of all the mismanagement, our freight rates are only about one-third of the lowest average known elsewhere in the world. Our average rates, according to Mr. Depew, are only 8 mills per ton per mile. Those of Great Britain are 2 cents and 8 mills, or three and a half times as much as ours; those of Russia, 2 cents and 4 mills; of Italy, 2 cents and 5 mills; of France, 2 cents and 2 mills; and of Germany, where the government owns the railroads, 2 cents and 4 mills, or exactly three times the rate of our roads.

The rates given by the Inter-State Commission differ slightly from Mr. Depew's figures. They are as follows: in Great Britain, 2.80 cents; in France, 2.20 cents; in Germany, 1.64 cents; in the United States, .878 cents in 1893, and .866 cents in 1894.

This difference, however, is not very material for the purpose in view. The comparison, however, demonstrates the wonderful results which the immense magnitude of our railroad system—about twice the length of the aggregate systems of the world—and our geographical position have enabled us to attain. Its predominating advantages to our commerce are incalculable. Let us, then, make the best use of these advantages by more efficient management, and thus gain a higher preëminence among the nations of the world. Let our railroad system be so developed and expanded in the future that all the people may be made partakers in a still greater degree of the national prosperity which it is capable of conferring upon us; and, while the wealth of the family of Crœsus shall be accorded all that the law and fair dealing allow in the field of investment, let it be in all respects subordinate to the general interest and welfare of the republic, and that without any paternalism, Socialism, Populism, or Anarchism.

WILL TRUNK LINES BE OPERATED BY ELECTRICITY ?

By Frank J. Sprague.

WILL trunk lines be operated by electricity ? This is a question which is naturally asked, whether by the engineer who, with a knowledge of what has already been accomplished in the face of many difficulties, seeks to determine the ultimate development of a great industry, or by the layman who, with a casual knowledge of the advances of the past few years in the various departments of electricity, but with no technical knowledge, easily conceives an imaginative future of vast possibilities.

Every one, however, who has been at all identified with the growth of any industrial development, or who is familiar with the difficulties encountered and surmounted, knows that sentiment has not determined the present status of, or materially aided in, any great electric development, whether it be in the field of the telegraph, the telephone, the electric light, the electric railway, or the electric elevator.

Each of these has won its present position in the commercial world in the face of great opposition, and only after having demonstrated its utility in facilitating intercourse and communication or in conferring great benefits upon mankind, while at the same time achieving economies in life and a substantial income upon investments.

This is true with every industrial development, whether it be in the department of electricity or not ; and it may be safely stated that in this particular science there will not be material advances except such as accomplish manifest economies and show a commensurate return. One hears many prophecies as to the future of the electric railway. It has been said that the epitaph of the locomotive has been written,—that the trunk-line road awaits early transformation. The ordinary laws of the transmission of energy, the restrictions of earning capacity, the ratio of investment to return, established lines of intercourse and habitation, geographical outlines, climatic conditions, and the existing limitations of terminal facilities are set at naught by the over-enthusiastic prophet with a happy *nonchalance* ordinarily unproductive and misleading.

It is perhaps unfortunate for these exuberant individuals that the financial question is so serious a factor in determining the growth and the limitations of any industry, but nevertheless it is a fact which cannot be ignored. So in all soberness let us consider briefly, then, what has been done in the electric railway, and what are its possibilities.

Seven years ago there were in existence as many electric railways of all kinds and characters, experimental or commercial, as could be counted upon one's hands. Scarcely any two were alike. None represented the system of to-day. None could be counted other than of a tentative character.

The birth of the present trolley system may be fairly put down as at Richmond, Va., which line was opened in February of 1888 by the Sprague Electric Railway & Motor Co., and of which there appeared in the ENGINEERING MAGAZINE of September, 1894, some personal reminiscences by the writer.

Since then there have been put into operation in the United States, England, France, Germany, and Italy, not less than seven hundred electric railways, covering not less than 7000 miles. There has been invested in the electric railway industry fully $250,000,000, and there are to-day connected with it fully one hundred thousand people. The once laughed-at and despised trolley, now alternately praised and condemned, has become a most potent factor of our busy life and civilization.

It is true that it has oftentimes disfigured streets, but, while it has occupied the air, it has been instrumental in forcing other wires under ground. It has given us better-paved streets, greater cleanliness, more perfect tracks, and luxurious, well-lighted, and well-ventilated cars; and with the higher speeds it has made possible the extension of the taxable and habitable areas of towns in a much greater ratio than is represented by the increase of speed. It has released from the most cruel drudgery tens of thousands of animals; it has given employment to an army of men; it has improved the telephone service by forcing the abandonment of the ground circuit and the adoption of the metallic circuit; it has shortened the time of transit between our home and business; it has bettered the *morale* of employees, who, instead of urging on jaded beasts, have become the operators of an unfeeling, but tractable, machine; it has built up unoccupied territory; and it has given employment to idle capital. It has even built up homes, though it has devastated some; and though it has oftentimes been a juggernaut, the fault has not been entirely its own.

In short, the trolley system is perhaps the most remarkable example of an industrial development that the world has ever seen, and yet when, impressed by the greatness of this industry and made familiar with the changes which it has wrought in so short a space of time, one asks: "Will the electric motor replace the steam locomotive? Will trunk lines, as such, be operated electrically? Is the field of the electric motor universal, or is it special." We must answer as we would to the questions: "Will the telephone replace the telegraph, or the electric light the manufacture of gas?" And the answer is: It is not exclusive, its reign will not be universal. In fact, all industrial developments on great and extended lines which have proven and are present boons to humanity, and make effective use of natural laws, must each and every one, and not one to the exclusion of all others, be utilized in our complex system of life.

The electric railway, even in the field it already occupies, has not accomplished everything, or by any means solved all the problems of transportation; and, when we consider its application to existing railways, and look forward to see what the probabilities are of a wholesale and exclusive utilization of electricity for transportation purposes, we must consider what it has not done, and at the same time see why the advances already made have been so phenomenal.

There are many reasons. First of all, there exists the universal necessity of transit, whether it be urban, suburban, or trunk-line. Travel is our natural law, whether from house to office, from town to city, or from coast to coast, and every available means which will facilitate traffic, whether by animal or mechanical power, will naturally be used.

In the great street systems which have spread all over the country the motive power in the past was principally animal. It was the most natural, but at the same time one of the most expensive, and in many respects an unsatisfactory, service. Where heavy duty was required, it was most deficient, so that the cable came in time to be recognized as a preferable mode of locomotion under certain restrictions,—in other words, the application of steam power instead of animal power, wherever the investment and the amount of traffic warranted it.

When, therefore, it had been demonstrated that electricity, whatsoever its nature, could be utilized as an active agent for the transmission of energy from a central station to reasonable distances covering existing lines ordinarily operated as tram systems; when it was found that there would be a saving in the cost per ton moved, that increased speed could be attained, that more people could be carried, and that greater areas and distances could be covered,—what more natural than that the trolley should take the place of the horse?

Branching out from these systems, there naturally came more ambitious lines, not perhaps so much in the total duty done or in the weights carried, but rather in the distances run, the speed attained, and, in a small degree, the electrical pressure used.

On suburban lines the speed was naturally increased because the street-traffic conditions were less limiting. These lines have often paralleled existing steam lines, whose traffic they have somewhat seriously interfered with, but they have, in addition, created a traffic of their own. They have generally followed existing highways, and have had the advantage over the steam road, not in the actual speed maintained, but in the fact that, with lighter roadbeds and as single units running at short intervals and at a good speed, they have more efficiently served a number of people.

Frequent cars, stopping wherever required to take up or deliver passengers, and with a minimum fixed rate of fare, naturally can give a better service, even with a reduced rate of speed, than more infrequent and larger steam trains stopping only at predetermined stations.

All this has made it possible for the electric railway to create a traffic of its own as well as take away a portion of the traffic of the steam railways. This sort of development will go on, until the trolley system is almost as common as the turnpike. It will establish lines of communication which have not hitherto existed ; it will build up new territory ; it will act as a feeder to great trunk-line systems, both for passenger and certain classes of freight work ; and it will largely encroach upon special fields now occupied by the trunk lines.

But, when we depart from this class of service and take up what is essentially a trunk-line system, there are many questions to be considered,—and not alone those of the local and express service, but also a most important one, which is rarely considered when electric railways are talked of; I refer to the trunk-line freight service,—that is, the transportation of goods in great bulk over long distances. One must remember that trunk lines, as they now exist, have been built up by a slow process, and that no very serious change from their existing conditions can be made, considered from the commercial standpoint, except after grave deliberation and at very great expense. Unless passengers and goods can be moved over a system with increased benefit to a community, or at a reduced cost, or with a commensurate return on capital invested, an electric will not replace a steam system. Of course, in these remarks I ignore specific problems, such as the utilization of a storage battery and motor in place of a locomotive, or of a moving central station, as is being tried on one of the French lines, or those special problems like the Baltimore tunnel, in which an electric locomotive will be utilized for a short distance in place of the steam locomotive ; I am considering the possibilities of what is generally considered an electric system, —that is, the operation of a number of train units from a central station.

If we were to refer for a moment to any other system of transmission of power,—for example, by water or air,—no one for a moment would question its limitations. We all know that any amount of power can be so transmitted, but only with definite losses which depend upon the pressures used, the sizes of pipes, and the distances and amount of energy transmitted. So it is in the transmission of electricity, which is nothing more or less than an agent whose exact character we do not know, but whose obedience to certain empirical laws is absolute.

It is unnecessary here to repeat the specific laws covering such transmission ; they are perfectly well known, and there is no practical hope of their being changed, any more than the laws of gravity. Recognizing these laws, there is a distinct limitation to the distance and amount of power which can be economically and conveniently transmitted and distributed, no matter how perfect the generating or receiving machinery may be ; and these two particular elements have been brought very nearly to their maximum possible efficiency.

It may be said—which is perfectly true—that, if from a central station one can conveniently operate a number of distributed units over a 20-mile road, why cannot two, or, for that matter, a dozen such systems be connected together? So they can, but this does not form a trunk-line system. Of course, if we consider the steam trunk line from a passenger standpoint, the present system has defects, and the principal one is the inconvenience of service when considering short distances. If one is going a long distance, then it matters not so much whether trains are two or three hours apart in leaving ; but long-distance travel and short-distance travel have not the same requirements so far as the passengers are concerned.

If nothing is sacrificed, it would be preferable, of course, to have smaller units despatched at more frequent intervals, no matter what the distance of travel. But, as I say, this is less important when dealing with long distances than when dealing with short ones. When trains are operated in large units, with comparatively few units between terminal points, and these at considerable intervals, the steam locomotive will absolutely hold its own. When, however, these larger units are broken up, the intervals of train-despatching can be shortened as much as is consistent with satisfactory operation, and the number of units distributed over a line made correspondingly large ; then, and then only, will electricity be used on suburban lines and lines connecting important cities.

I have again and again advanced the substance of this statement, and I must here repeat and emphasize this fact,—that, so far as passenger service is concerned, considering for the moment only economy of operation, the problem narrows itself down to the number of train units operated between terminal points. Make that number sufficiently large, and the electric motor is the best means of propulsion, whether for high or low speed. Decrease this number, and you must rely upon steam.

Or, putting it another way, the answer to the query, will electricity take the place of the steam locomotive for railway service, is: only in part, and then only when the number of units operated between terminal points is so large that the resulting economy will pay a reasonable interest on the combined cost of a central-station system of conductors and the motor equipment, and the traffic existing is commensurate with the needs of such a system.

It is perfectly true that, looking only at the time standpoint of passenger traffic, it is entirely possible and feasible even, not only to operate any existing street or elevated system, and many of the suburban systems, but also the traffic between such points as New York and Philadelphia, on a subdivided electric service; but this is not all that is required. The more frequent the units despatched over the track, the more exclusive must be that particular track for that particular service, and the larger must be the number of tracks to take care of all the varied service of a great system.

Briefly, the service may be characterized as the transmission of passengers from one local point to another and the transmission at high speed between principal points,—that is, way and express service,—and the handling of freight in great masses with all the attendant switching and distribution at way and terminal points. Considering only the transit needs of these various services, a six-track railroad might be considered desirable, and probably would be; but there are many problems connected with such a road, to say nothing of the fact that it would often be impossible to construct such a system on existing rights of way. Independent of the matter of investment, rights of way, or construction, the problems of switching, passenger landings, and freight acceptance and delivery, on a six-track railroad would be a grave one.

Freight cannot be handled like live loads. A succession of cars each with twenty or thirty passengers might well take care of all the passenger traffic on a road, but freight cannot ordinarily be handled in any such way, except by an enormous increase of expenditure. The 30-, 40-, or 50-car train, pulled by a single locomotive with a limited train crew, presents an economical transportation of freight which no system of units on long-distance transportation can hope to equal.

It may be contended that there is a way to create a six-track service, and that it can be operated partly electrically and partly by steam, and that the small units for way service can be run on one set of tracks, the express units on another, both subdivided, and that larger freight units at long intervals can be operated on the third. But this proposition will not appeal with any practical force to a railroad man, or to the electrical engineer as such, because it is absolutely vital for successful electrical operation from a central station that the units shall be divided, and that there shall be a distributed service, and not a localization of large units at long intervals at any portion of the system.

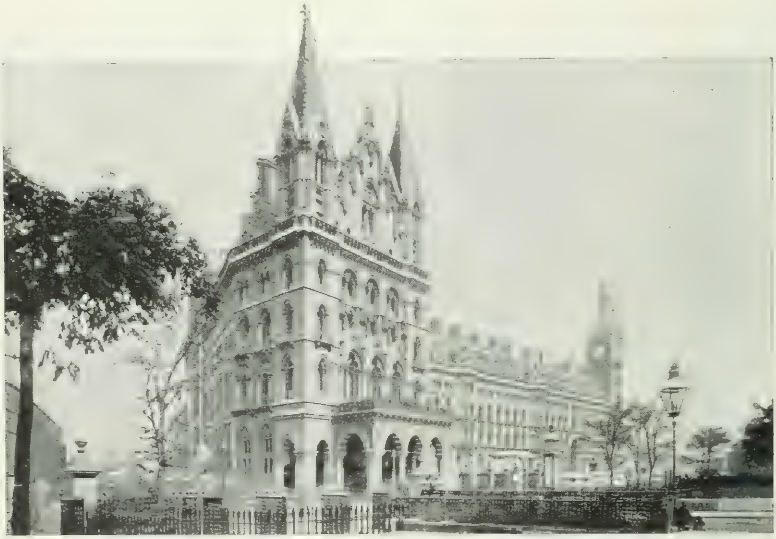
It seems hardly necessary to even refer to the question of signals, and all the difficulties which would exist if an attempt were made to operate a road simultaneously with electricity and steam. Human life and its absolute dependence on these signals, which neither natural laws, stress of accident, or the conditions of weather should interfere with, make this of vital importance in considering any change.

One of the great advantages of the electric system, as generally used, considered from a traction standpoint, is the fact that the motors are carried under each individual car, or, with few exceptions, under one of two or three cars, thus giving the advantages of a high proportion of weight for traction, with the consequent distribution instead of localization of weights. When motors reach their highest standard, every car can be made an individual unit, which can be operated in any combination and from any point of a train, but this advantage instantly disappears when it is attempted to use an electric locomotive after the manner of a steam locomotive,—that is, to put it ahead of a number of car units whose aggregate weight may be from five to twenty-five times its own. It must, then, in a large measure be limited by identically the same laws in the matter of weight and traction as the present steam system. Assuming units which are common on steam roads, such as 1000 or 1500 h. p., the enormous loss of energy and the variation of pressure on a line would make the cost with any possible allowable loss entirely impracticable.

Let us lay aside, then, some of the visionary prophesies concerning electric railways. Perhaps no one has been more actively identified with them than myself; no one, I think, has greater faith in the future of the electric railway than I; but its future is not in the wholesale destruction of existing great systems. It is in the development of a field of its own, with recognized limitations, but of vast possibilities. It will fill that field to the practical exclusion of all other methods of transmitting energy; it will replace the locomotive on many suburban and branch lines; it will operate almost all street-railway systems and elevated and underground roads; it will prove a valuable auxiliary to trunk systems; but it has not sounded the death-knell of the locomotive any more than the dynamo has sounded that of the stationary steam engine. Each has its own legitimate field, which will play its proper part in the needs of all civilization.

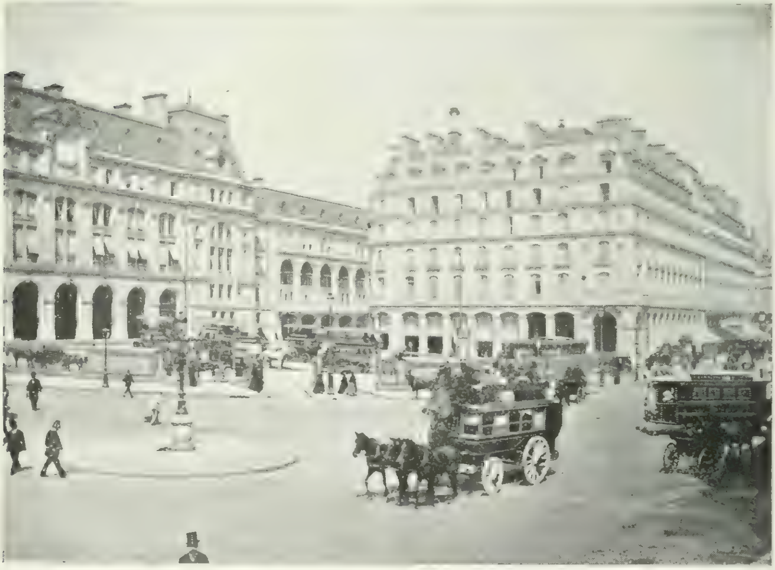
THE ARCHITECTURE OF RAILROAD STATIONS
BY BRADFORD L. GILBERT.

T is scarcely more than half a century since the architecture of railroad stations became a necessity or even a possibility. As the railroad station is the one architectural object which Americans see everywhere and with the greatest frequency, and the one in which many thousands daily have nothing better to do for hours than await the departure of their trains, there is to-day no other field of architecture which offers such wide opportunity for the most potent and elevating



ST. PANCRAS STATION, TRAIN SHEDS AND TERMINAL HOTEL, LONDON.

architectural education. Until a comparatively recent date, however, cheapness alone was the principal consideration in the erection of stations in this country, placing them in strong contrast to such buildings abroad, where, with the exception of the churches and some pub-



LA GARE SAINT LAZARE, WITH TERMINAL HOTEL, PARIS.

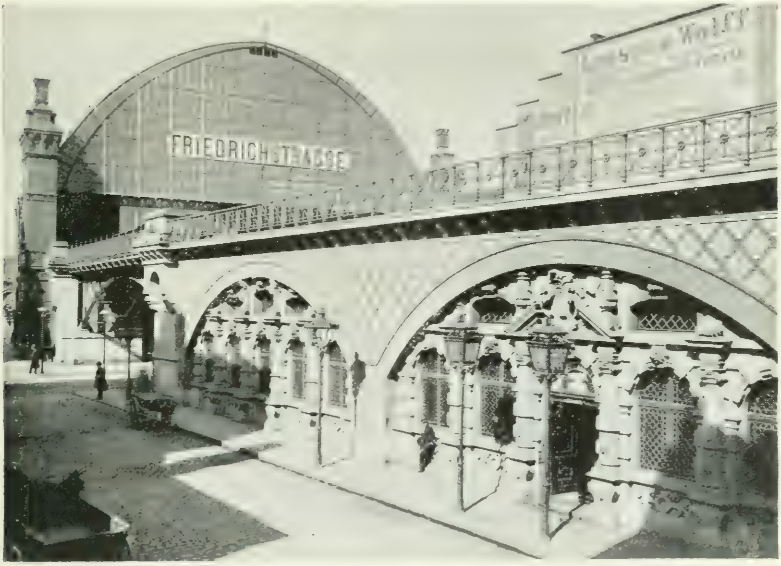
lic buildings, the railroad stations seem best to illustrate the typical architecture of each country.

The following illustrations have been selected to demonstrate this fact, and they form part of a personal collection gathered upon a recent extended foreign tour, made for the purpose of studying railroad-station problems.

The photographs speak for themselves, requiring only general explanation.

The buildings, upon personal inspection, indicate careful study and adaptation to the site and all requirements.

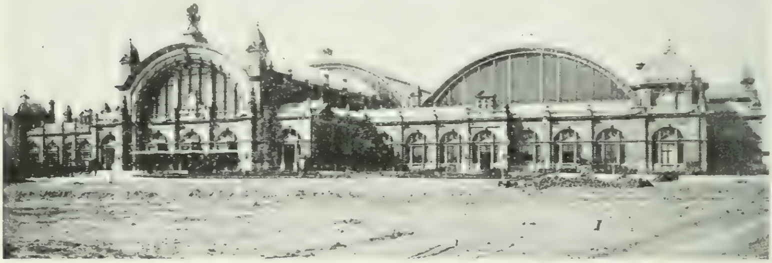
The St. Pancras terminus is possibly, with one exception, the best known of the station buildings in London, considered from an architectural standpoint.



FRIEDRICHSTRASSE STATION, SHOWING STORES UNDER VIADUCT.

On the continent, however, with few exceptions, the general exterior design of the principal stations can usually be recognized as the work of an architect, and the effect is certainly a vast improvement over the treatment of the problem from an engineering standpoint only.

Even were it possible to cover all the tracks within the Paris station train-shed with one (or even two) single-span arches, as is so frequently the case elsewhere, and as shown at Friedrichstrasse, the proportion still would be far better with the use of intermediate supports,



PHOTOGRAPH SHOWING PRINCIPAL FAÇADE OF UNION STATION, FRANKFORT ON THE MAIN.

the expense certainly less, and the practical service equally good. In the photograph of the Terminal Hotel connected with the Paris station the café in which the recent bomb explosion took place is plainly seen. The revenue from rental derived from the otherwise useless space under the viaducts of the Metropolitan Railway of Berlin, including Friedrichstrasse as shown, should appeal to the practical, if not the artistic, sense of railroad officials generally.

It is seldom the case that a large terminus is planned with enough foresight, or, more correctly speaking, with enough realization of

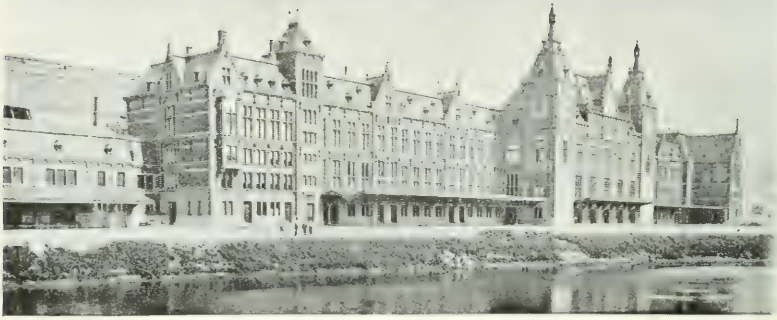
INTERIOR OF GENERAL BOOKING OFFICES AND CENTRAL HALL, UNION STATION, FRANKFORT ON THE MAIN.

actual future growth, to provide for later developments and actual traffic requirements, without considerable additional expense, and in a great measure destroying the unity and harmony of the original design. The formation of railroad terminal companies in so many of the large cities, to divide the vast expenditure required for enlarged ground space (actually made valuable in the first instance by the location of the railroad terminus), tells its own story. In a recent conversation with Col. Walter Katte, chief engineer of the New York Central, on this question, the importance of this was very clearly demonstrated by the extensive and expensive improvements now in progress in connection with the passenger traffic to and from the Grand Central Station, New York, which 25 years ago was believed equal to all future demands, and to-day is found totally inadequate. The same is true of the passenger stations at Philadelphia, Chicago, St. Louis, San Francisco, and other principal cities, where the companies have been rudely awakened to the truth, and in several cases have made provision accordingly.

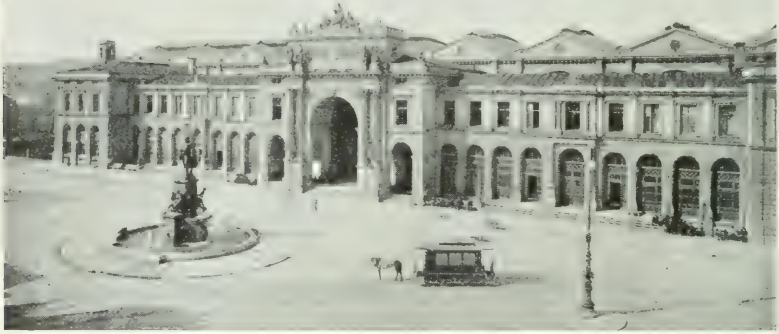
BELINZONA.—SHOWING USUAL TYPE OF LOCAL PASSENGER STATION.

As at Frankfort, it would in many instances undoubtedly prove a paying investment to purchase land just outside the city limits, construct new boulevards, and erect such railroad buildings as seem desirable for present needs and future development. The increased valuation and sale of the land would cover the first cost with a handsome profit for revenue.

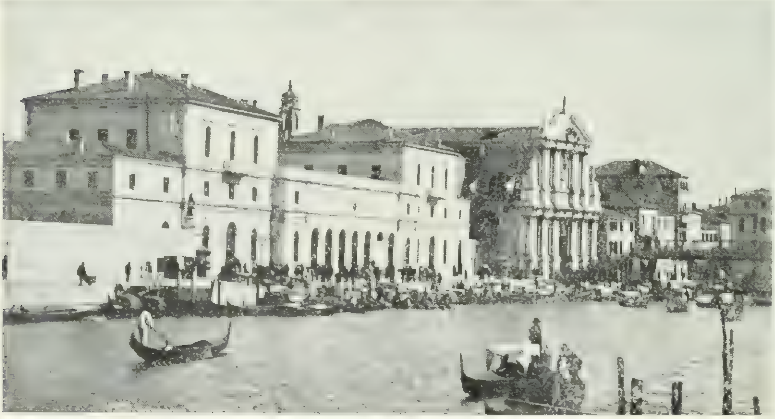
In the majority of instances first impressions are the more enduring, particularly of buildings and places. Pleasant environments, tastefully-



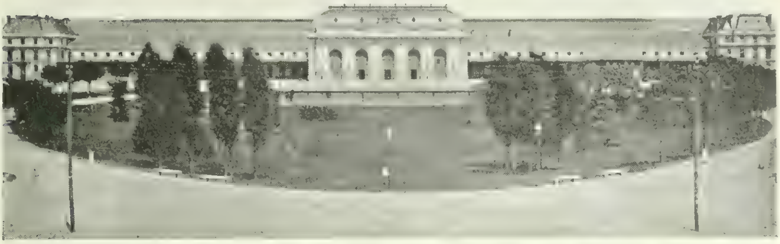
PRINCIPAL FAÇADE OF STATION AND OFFICES, AMSTERDAM.



RAILROAD STATION, TRAIN SHED AND OFFICES, ZURICH.



RAILROAD STATION ON THE GRAND CANAL, VENICE.



STATION, OFFICES, TRAIN SHED AND OPEN SQUARE, MILAN.

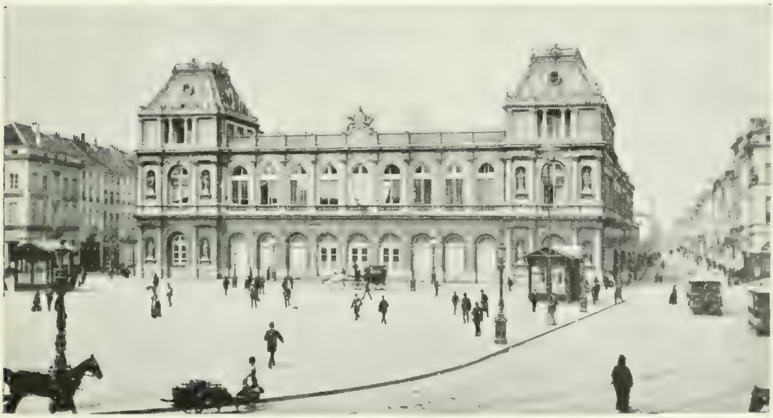
decorated grounds, the proximity of a public square, each help to set off the station to best advantage. The writer recalls several places where the open squares, temporarily loaned to the city by the railroad company have been partially utilized later at small expense for increased traffic accommodations, at great advantage to both the company and the public.

At Milan the large public square, just outside the city gates, gives an air of dignity to the station which it otherwise would not possess.

The reflection of the station at Amsterdam, with its towers and projections, in the placid river below, lends a quaintness and picturesqueness to the whole structure.

The station at Zurich, a city of a little over one hundred thousand inhabitants, will compare favorably with the stations in any of our own cities of equal size.

If the proverbial hackmen are missing at Venice, the noisy gondoliers fill their places with credit to themselves. The station is in

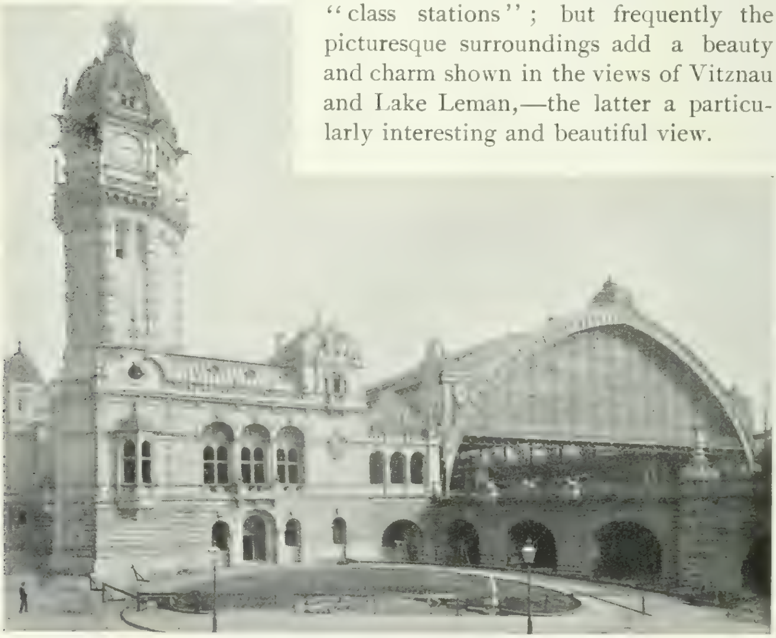


STATION AND TRAIN SHEDS AT BRUXELLES.

RAILROAD STATION AND OFFICES, DUBLIN.

keeping with the many handsome buildings surrounding it, belonging to the Renaissance.

The stations erected for the smaller villages and towns on the continent, all bear a strong family likeness, not at all unlike our own "class stations"; but frequently the picturesque surroundings add a beauty and charm shown in the views of Vitznau and Lake Leman,—the latter a particularly interesting and beautiful view.



RAILROAD STATION, VIADUCT AND TRAIN SHED, COLOGNE.

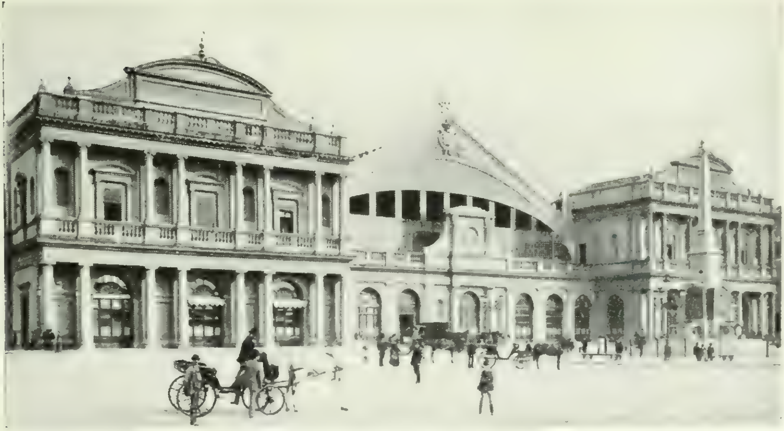
The growing public demand for railroad stations which afford comfort and convenience, as well as architectural beauty, deserves the attention it is receiving from railroad officials generally.

The widespread territory covered multiplies the opportunity for the use of varied building material and designs, meeting climatic influences and local conditions to an extent beyond all known precedent.

Architecture should so far become a delineator as to indicate upon its face the character of the work it is intended to portray.

A good design, graceful contour, correct constructional outlines, and symmetrical proportion, carried out in permanent material, necessarily combine to form the elements of all successful architectural work.

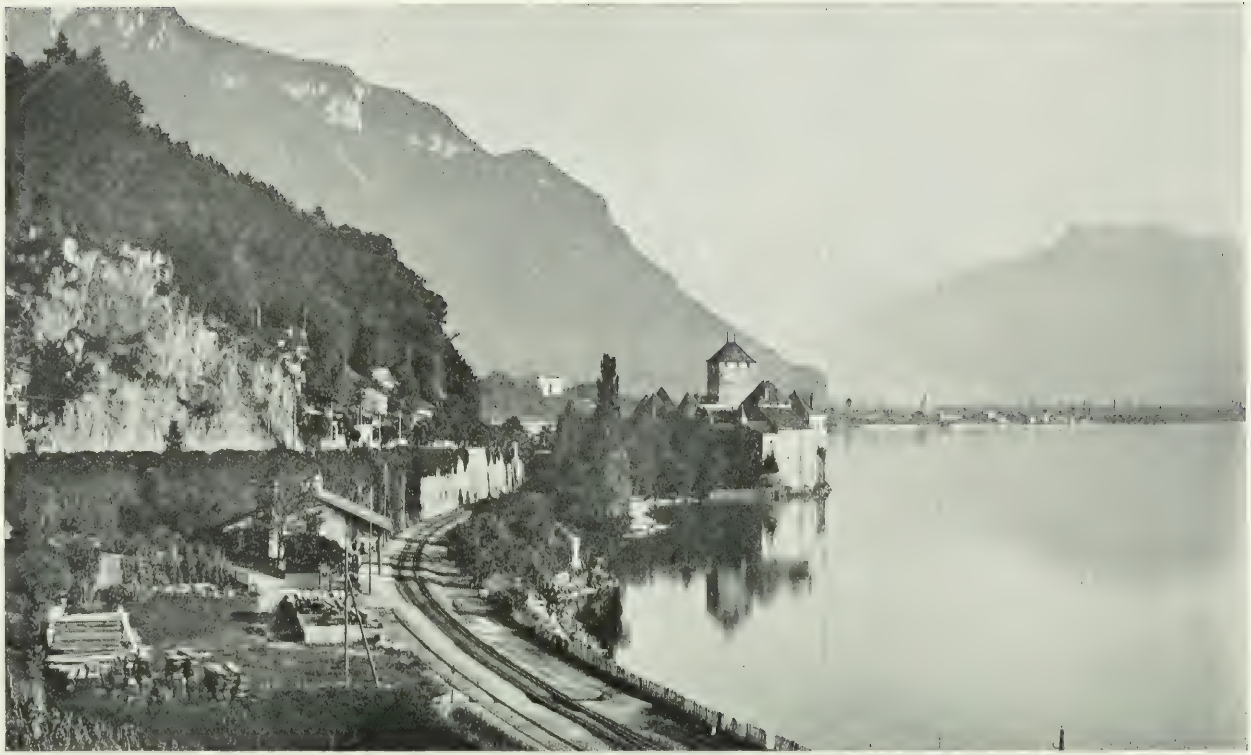
Architectural beauty alone in buildings cannot be said to have any justifiable existence. It should be made secondary to both construction and utility. These should become the fundamental and underlying principles of all correct design.



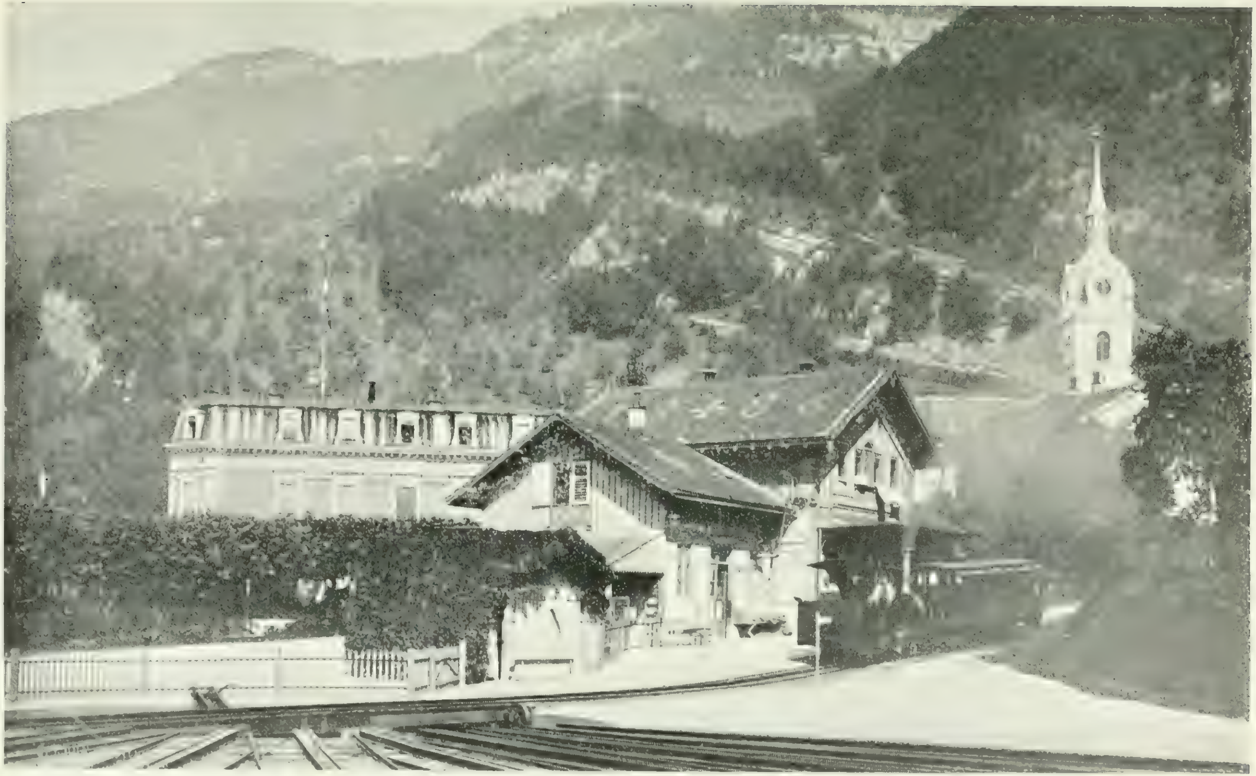
PRINCIPAL STATION, OFFICES AND TRAIN SHED, ROME.

Considering the general character of the buildings, probably no other distinctive style is capable of such freedom of treatment, or such variety of detail, in connection with station buildings, as what might be termed "modernized Romanesque"—an architectural treatment used so effectively by the late Mr. H. H. Richardson in almost the first of the station buildings to attract special notice in the vicinity of Boston.

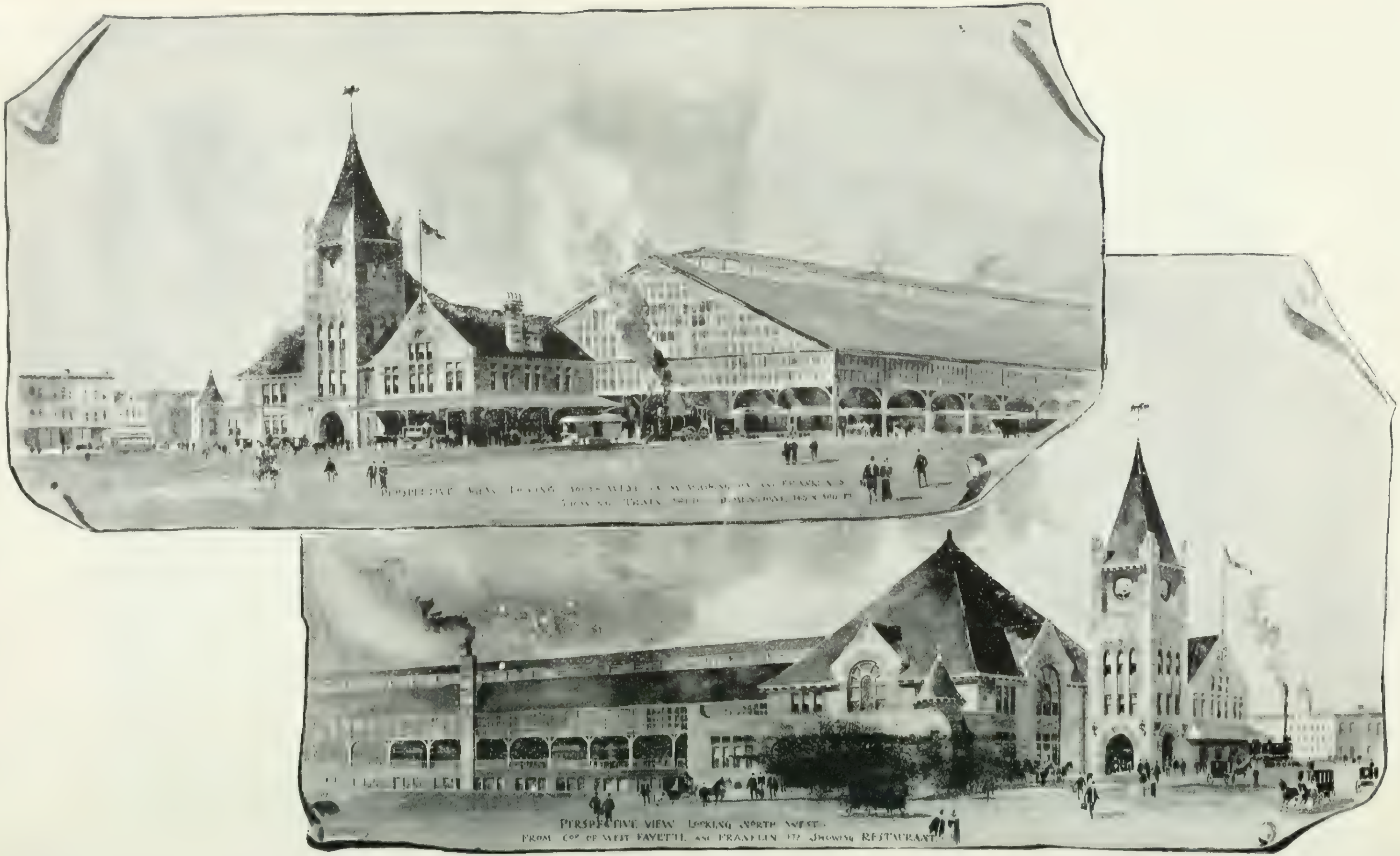
It may not be generally known that the "Romanesque" has held its own among all other types for a longer consecutive period of the world's history than any other distinctive style of architecture, not excepting the Renaissance which immediately followed. Possibly in



LAKE LÉMAN: SHOWING THE PREVAILING TYPE OF SMALL STATIONS; THE CHATEAU OF CHILLON IN THE DISTANCE.



STATION WITH AGENT'S ROOMS, VITZNAU; SHOWING USUAL TYPE OF PICTURESQUE SWISS STATION.


PERSPECTIVE VIEW LOOKING NORTH WEST.
FROM COR OF WEST FAYETTE AND FRANKLIN STS SHOWING RESTAURANT.

STONE PASSENGER STATION, WITH LOCAL OFFICES, RESTAURANT AND TRAIN SHED, SYRACUSE, N. Y., ON THE NEW-YORK CENTRAL AND HUDSON RIVER R.R.

time we shall evolve from all the prevalent styles what shall prove a broad, natural, and truly national type of American architecture, based upon the best and most appropriate features of all the various orders; and what more suitable beginning can offer than the railroad station problem?

The American illustrations have been selected by the editor of this magazine from a collection of original black and white drawings and photographs, specially prepared to demonstrate the evolution in railroad station architecture during the last quarter century. These were personally loaned for hanging in the Exhibition Building erected for the New York Central Railroad Company at the recent World's Columbian Exposition, Chicago, and called forth much favorable comment both from American and from European railroad officials.

As examples of a portion of the railroad work personally carried out, it is believed they will possess a certain weight in verifying personal statements and suggestions on the subject of railroad-station architecture.

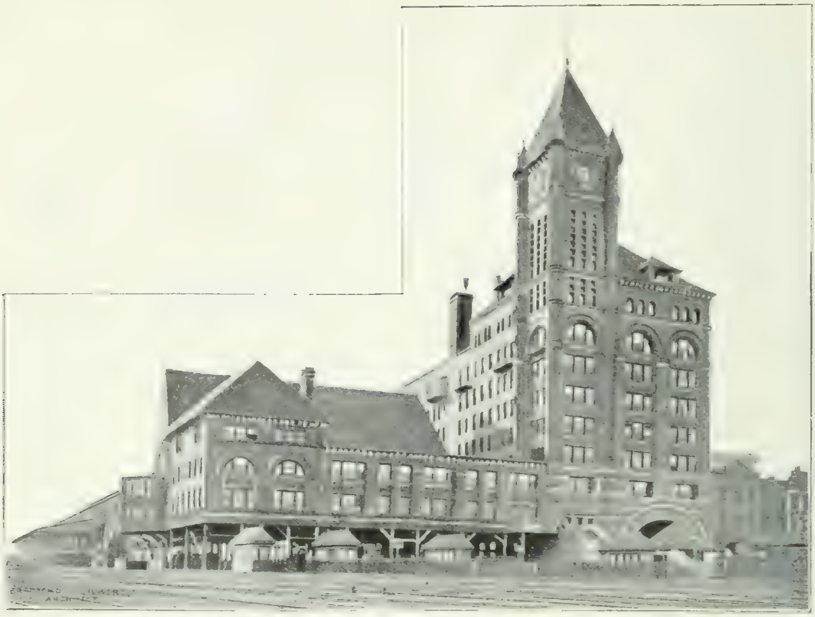
The Syracuse station as shown, on the New York Central Railroad, is constructed of granite with red sandstone trimmings, and is designed with a Romanesque motif throughout. The rotunda is 90′ 6″ square, and out of this open all of the principal rooms. Below is a large restaurant and lunch room, reached either directly from the street, or through a generous, well-lighted subway below the tracks. Local offices are arranged in the second and third stories, while a large train-shed covers all of the principal tracks and platforms.

The Illinois Central Railroad general offices and union station at Chicago was necessarily designed to meet the peculiarities of the site and actual traffic needs. It was opened to the public 10 months after beginning work, to accommodate the World's Fair traffic, and at a total outlay of about $1,800,000. The foundations necessarily formed one of the principal items of expense.

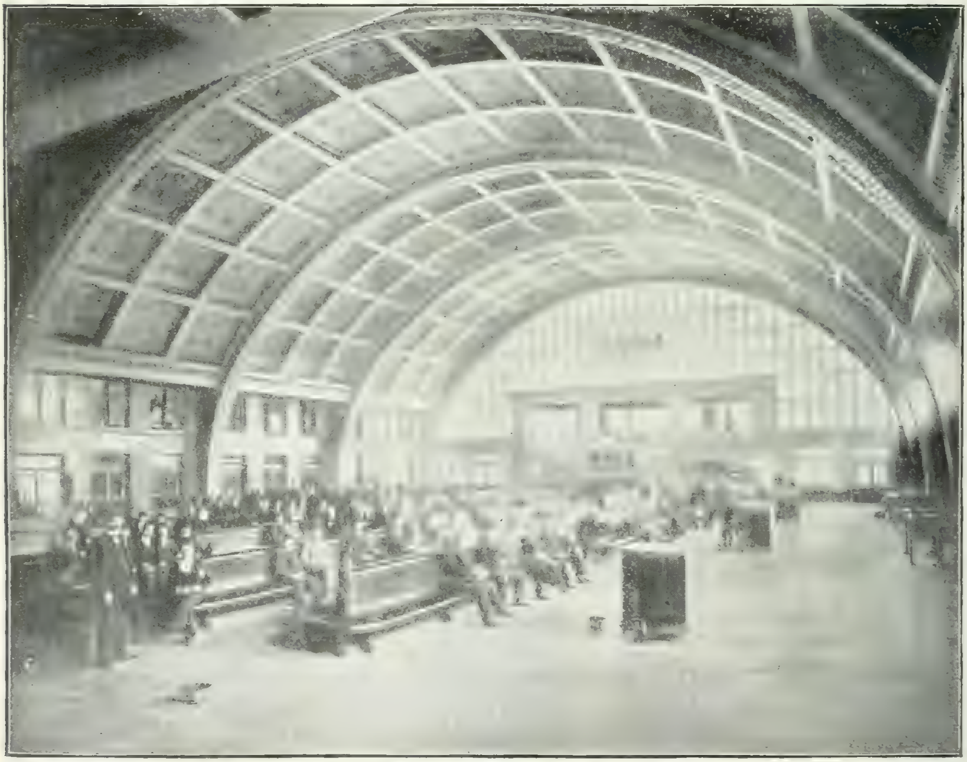
While the Illinois Central station might be called a terminal station, eight through tracks pass under the rotunda. Passengers are transferred to and from the platforms of the train-shed on overhead passages enclosed, or underneath by well-lighted, thoroughly dry subways.

From actual measurements, the floor space of the principal waiting-room or rotunda, as shown, is larger than the one given of Frankfort, which is said to be the largest on the continent.

The marble wainscoting carried to a height of about 14 ft., and the marble mosaic flooring, together with the fire-proof construction of the building, are intended to render it permanent. Separate waiting-rooms, smoking-room, barber's shop, large restaurant accommodations, etc., are shown on the photograph of the interior.



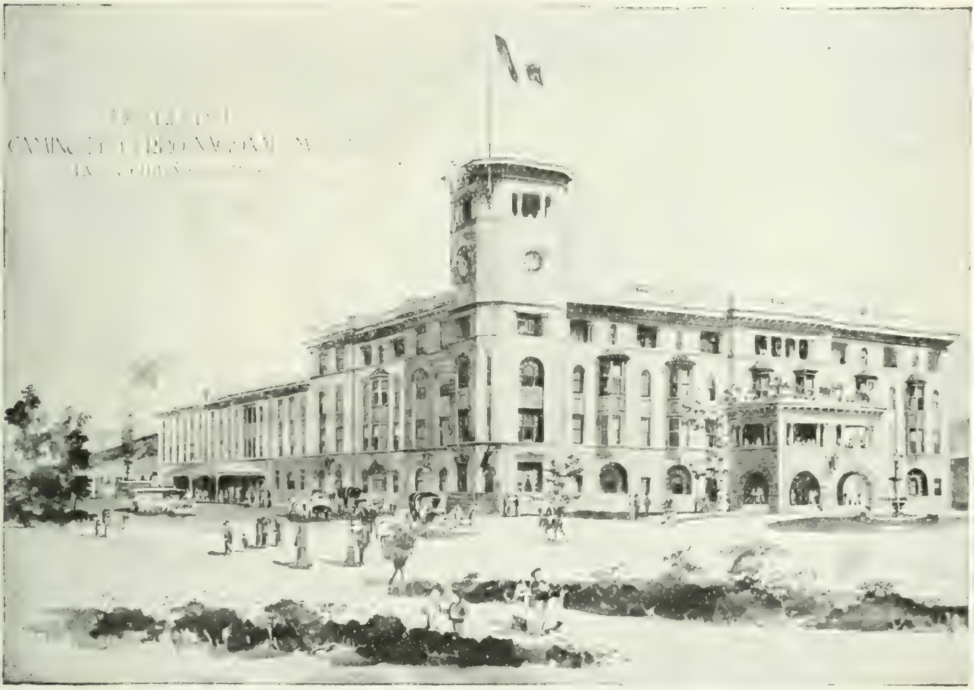
ILLINOIS CENTRAL STATION AND GENERAL OFFICES, CHICAGO.



Interior of General Waiting Room or Rotunda, (located over tracks) 150 ft. by 100 ft. Restaurant, Smoking Room, Women's Room, Barber Shop and all accessories connected.

The Mexican National station, with general offices and railroad hotel, was designed to meet these requirements and the climatic conditions of Mexico. A somewhat different plan, however, was adopted for the station now in course of erection at Colonia.

The station at Lowell, Mass., was located by the Boston and Maine Railroad Company upon a triangular plot of ground, with tracks on two sides and one of the principal streets across the end, while another crosses overhead above the passenger platform at the opposite end (as shown on the photograph), and is reached directly by a stairway.



RAILROAD STATION, GENERAL OFFICES AND TERMINAL HOTEL, DESIGNED FOR THE MEXICAN NATIONAL RAILROAD CO., MEXICO.

The station at Fall River, Mass., was erected for the Old Colony Railroad, before its consolidation with the New York, New Haven and Hartford Railroad system. It is intended to meet the needs of a wealthy community of upwards of seventy-four thousand persons. Milford pink granite, with trimmings, quoins, and voussoirs of Long Meadow sandstone, form the exterior, the detail treatment of which is shown on the photograph. The interior is finished in oak and hard pine throughout.

The union station designed to be erected at Manchester, N. H., contains various waiting-rooms and local offices, with large train-shed connected for the traffic of this large manufacturing city.

The station at Liberty on the New York, Ontario & Western Railroad is of frame construction, the outside being covered with shingles creosoted, while the roof is of slate. A wide passenger platform, extending in both directions from the building, and with seats framed between the supporting posts, connects the end baggage-rooms. The station is located on a curve, as well as on a considerable incline.

The Middletown, N. Y., station is of brick construction, containing large restaurant accommodations and local railroad offices.

The stations at Bridgewater, and Ashmont, Massachusetts, are constructed of granite for the exterior and of hardwood for the interior finish, with all known conveniences.

The small station at New Boston, Mass., is built of field stone, the gables roughly stuccoed in cement and pebble dash.

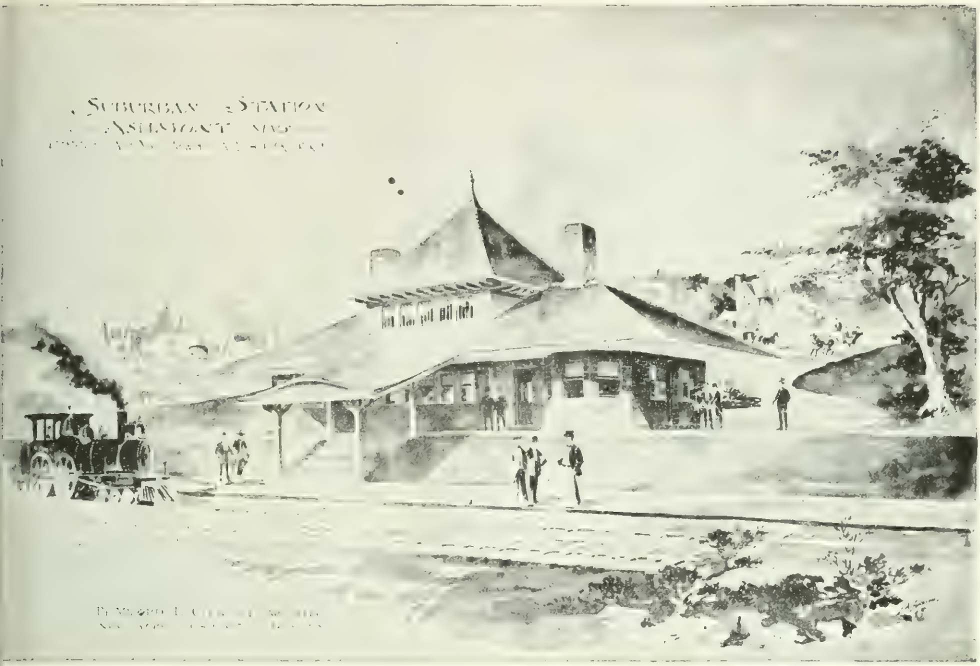
Essex Fells is a small but growing suburb of New York. The station is partly built of stone, with frame construction. The porte-cochère is located at one end. Above are rooms for the station agent. Built at a cost of under $3000, exclusive of platforms, this is a specimen of what can be accomplished at a small outlay.

The station at North Branch, N. J., is built of local brownstone with slate above, an example of a low-priced station, containing all modern improvements, including steam heat.

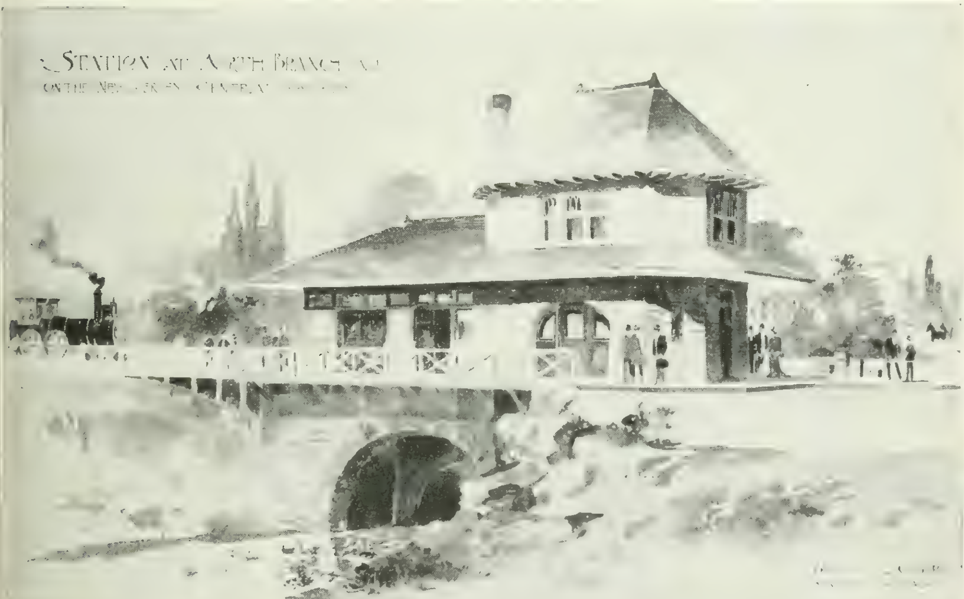
The station at Toluca, Mexico, is built of native stone, the greater portion of which was carried on the backs of peons and burros for many miles. It is designed to meet the three-class conditions of the country.

The station at Laconia, N. H., is built of granite. The central feature is the rotunda, from which all the other rooms open. This is lighted during the day by clere story windows above the roofs of the porte-cochère and wide passenger platforms.

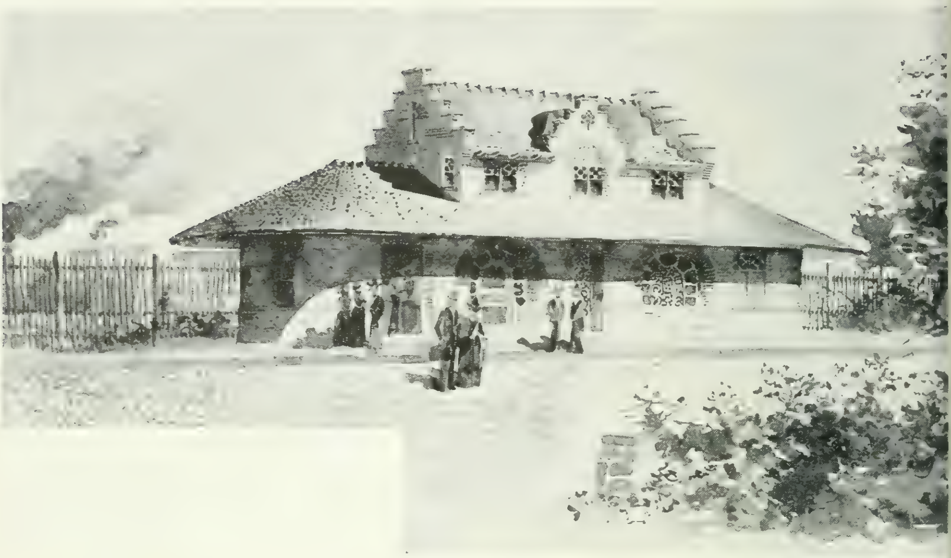
A layman is apt to judge of the success and value of a railroad by outward evidences of its wealth or taste and provision for public comfort. Railroad officials generally,—not excepting the chief engineer,—partly on account of their professional business training, principally on account of the high pressure under which they are constantly driven and the important business requiring their immediate attention, seldom have time to consider the artistic and architectural elements required to make their stations the success in these respects which they might readily become without any additional expense, and frequently at an actual saving in cost, if intrusted to any competent architect.



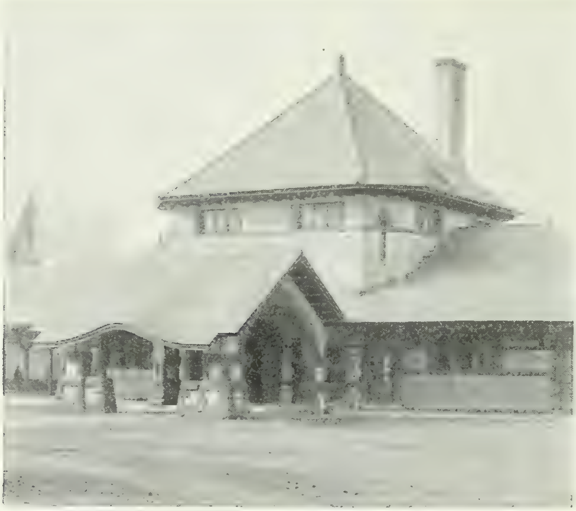
GRANITE SUBURBAN STATION AT ASHMONT, MASS., ON SIDE HILL, ERECTED FOR THE NEW YORK, NEW HAVEN AND HARTFORD R. R.


STATION AT NORTH BRANCH N J
ON THE NEW JERSEY CENTRAL

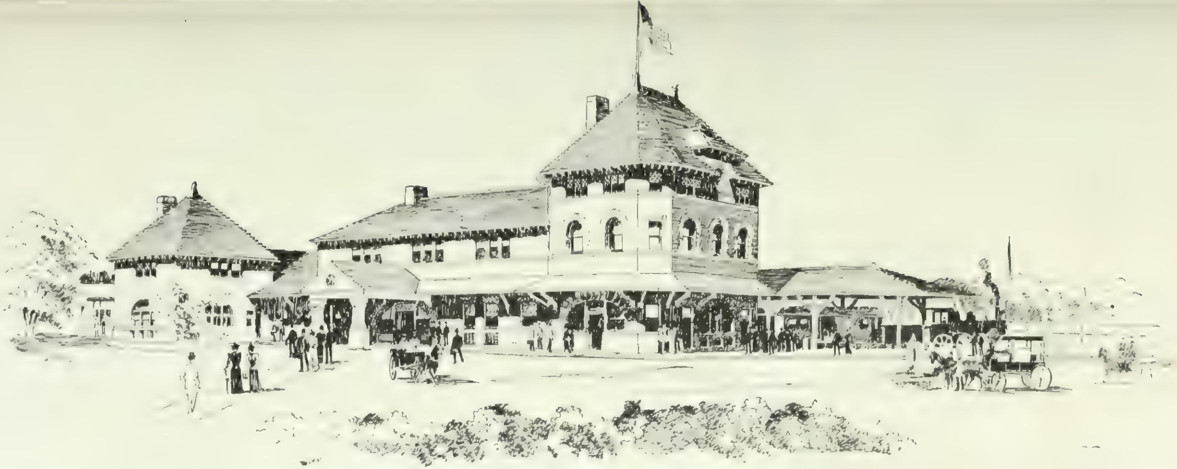
STATION AT NORTH BRANCH, N. J., ON THE CENTRAL RAILROAD OF N. J., ERECTED OF FIELD STONE.



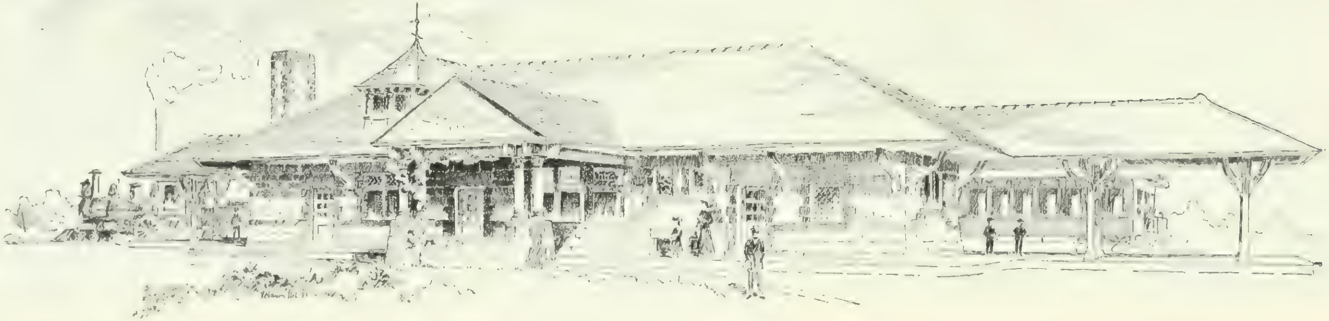
STATION AT TOLUCA, MEX., ON THE MEXICAN NATIONAL R. R.



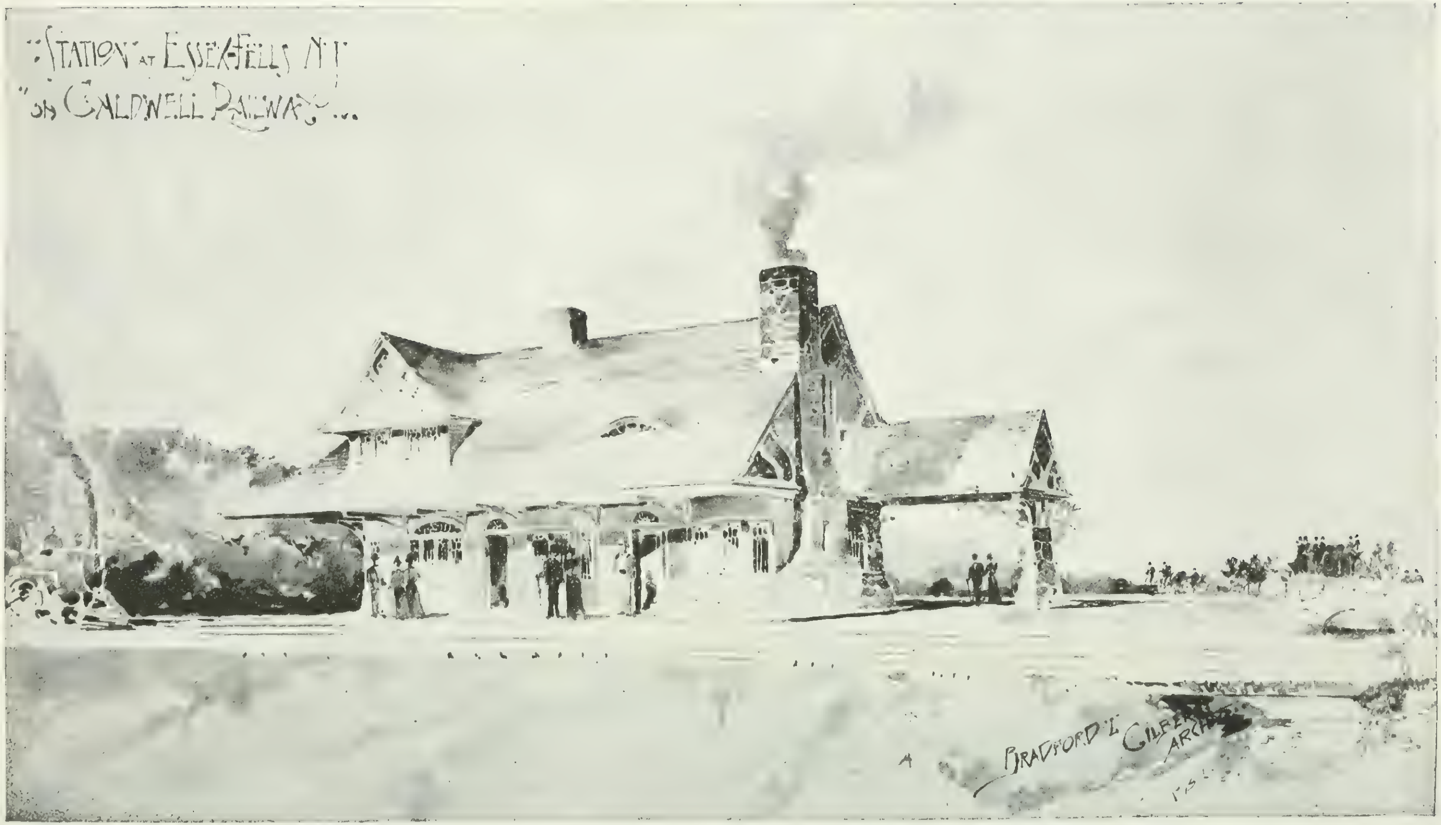
CENTRAL DOME OF GRANITE STATION AT LACONIA, N. H.,
ON THE CONCORD AND MONTREAL R. R.



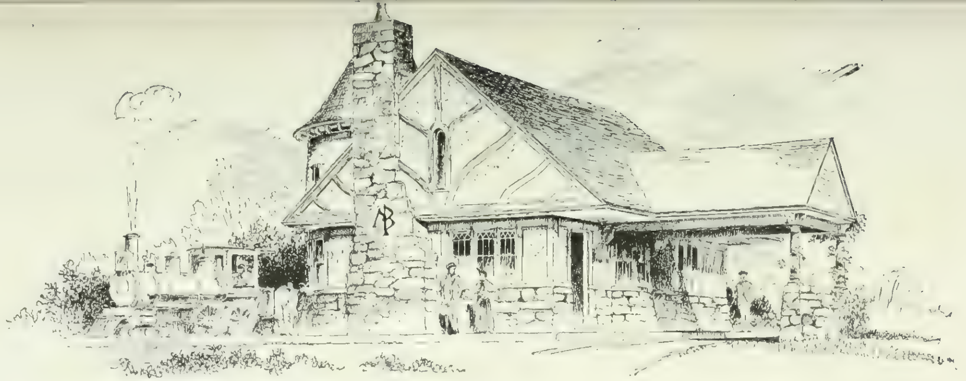
STATION, RESTAURANT AND LOCAL OFFICES AT MIDDLETOWN, N. Y., ON THE NEW YORK, ONTARIO AND WESTERN R. R.



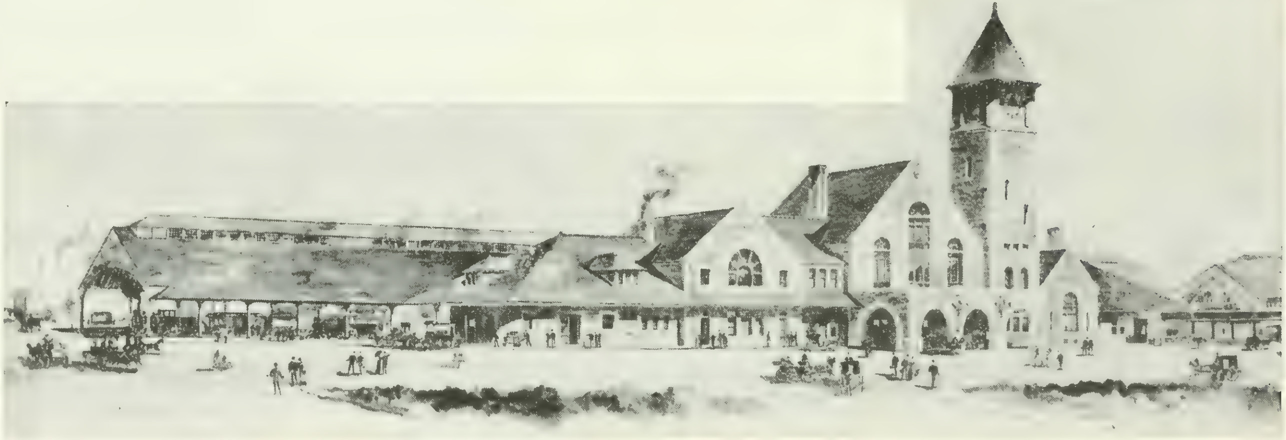
STATION AT BRIDGEWATER, MASS., ON THE NEW YORK, NEW HAVEN AND HARTFORD R. R., ERECTED OF MILFORD GRANITE AND BROWN STONE.



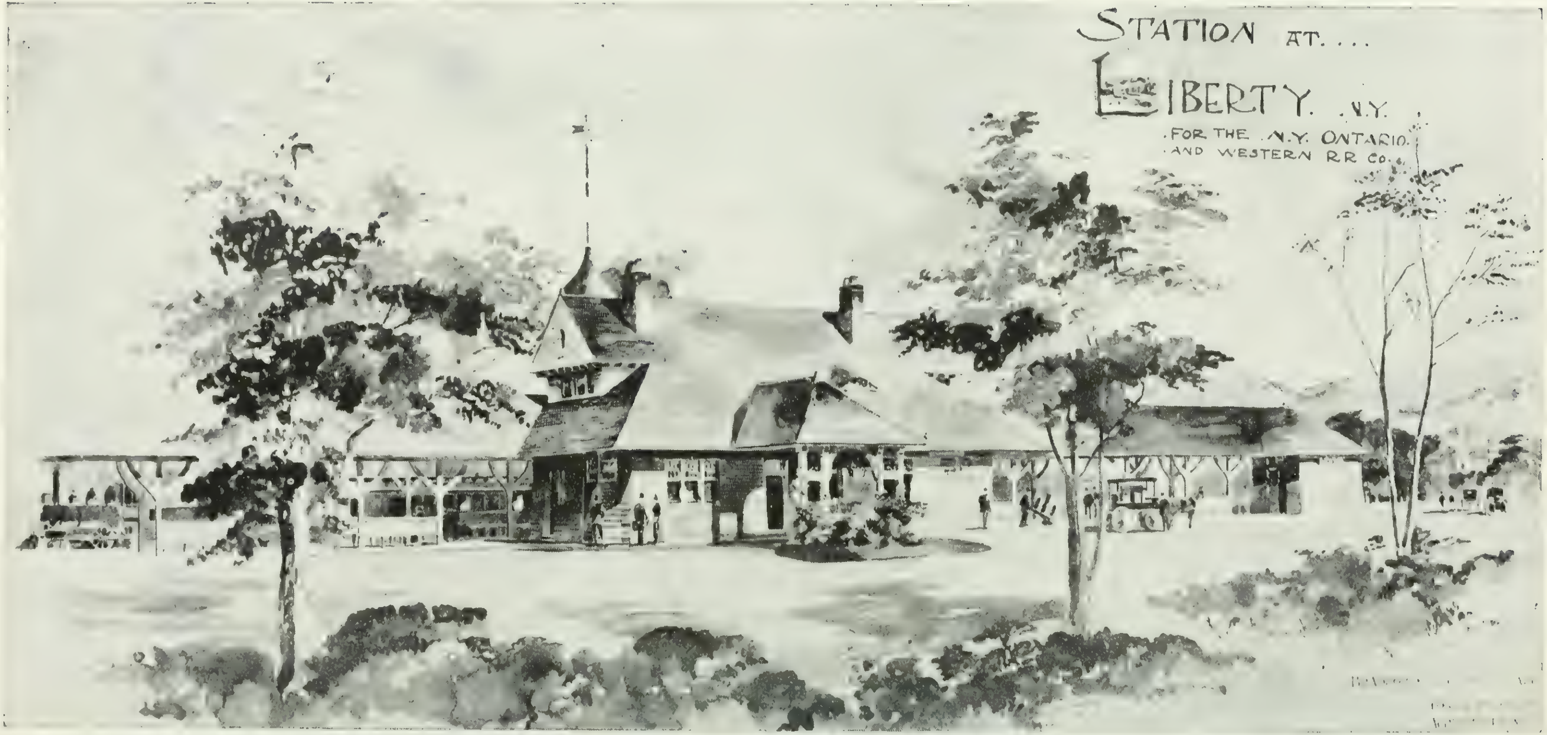
STATION (WITH AGENT'S ROOMS OVER) AT ESSEX-FELLS, N. J., ERECTED PARTLY OF FIELD STONE.



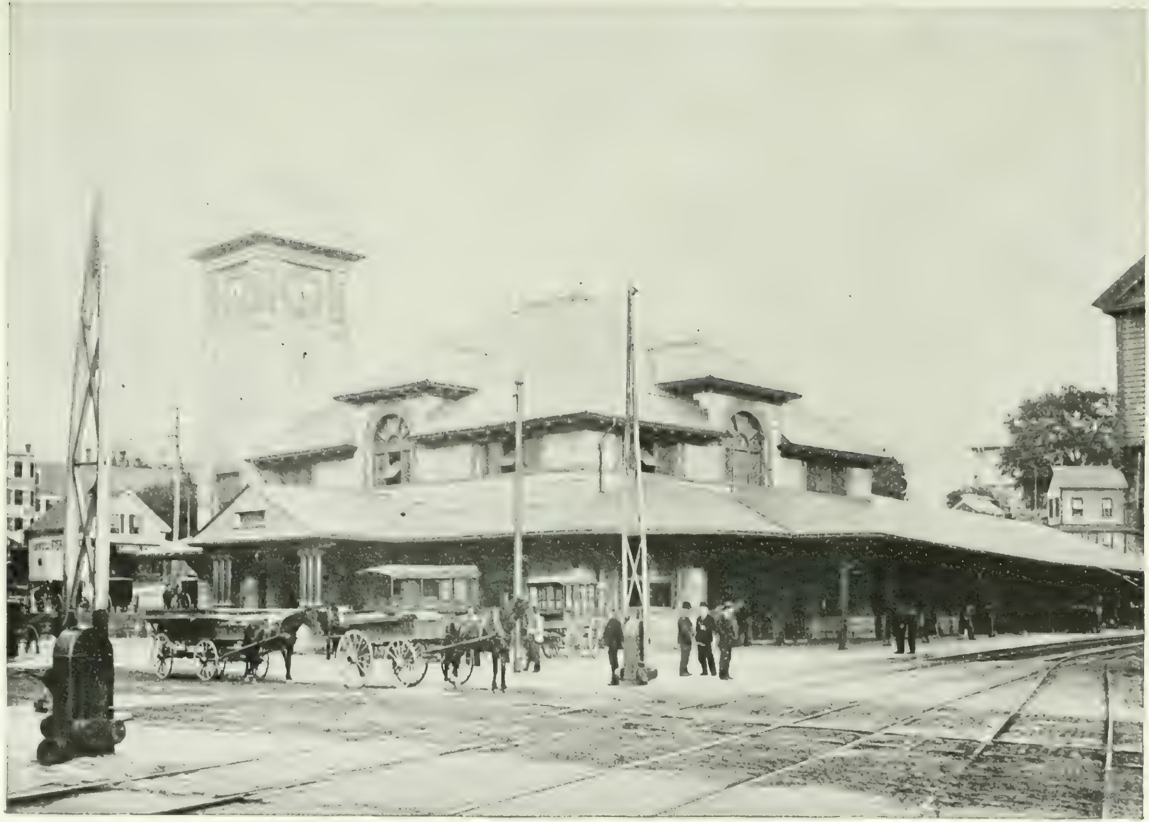
STATION AT NEW BOSTON, MASS., ON THE CONCORD AND MONTREAL R. R.



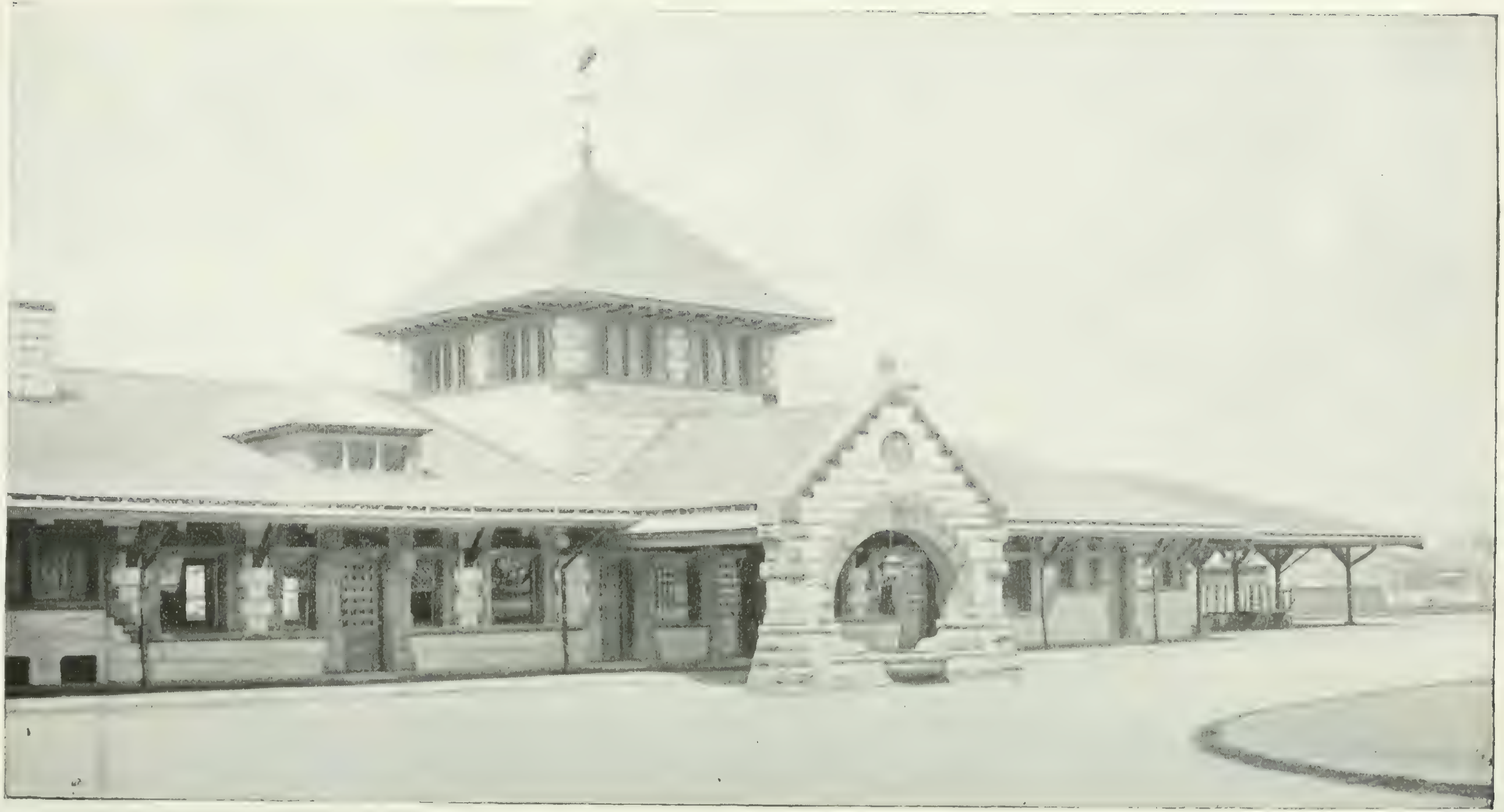
UNION STATION, LOCAL OFFICES AND TRAIN SHED, FOR MANCHESTER, N. H.


STATION AT....
LIBERTY. N.Y.
FOR THE N.Y. ONTARIO
AND WESTERN R.R. Co.

FRAME STATION WITH DOUBLE BAGGAGE ROOMS ERECTED AT LIBERTY, N. Y., FOR THE NEW YORK, ONTARIO AND WESTERN R. R



TRIANGULAR STATION (TRACKS BOTH SIDES) AT LOWELL, MASS., ON THE BOSTON AND MAINE R. R.



GRANITE STATION AT FALL RIVER, MASS., ERECTED FOR THE OLD COLONY RAILROAD CO. PHOTOGRAPH SHOWING DETAIL WORK AND CARVING OF PORTE COCHERE, LOGGIA, TURRET, ETC.

THE ADVANCE IN RAILROAD SECURITIES.

By Thomas L. Greene.

THE great advance in quotations for stocks and bonds which began in April, and which has affected almost every security dealt in on the stock exchanges, is a movement of the first importance to the railroad industry. To show how general has been the advance and to what extent it has gone, the following table, covering a number of typical railroad shares, has been compiled :

Stocks.	Lowest Price in 1895.		Price June 1, 1895.	Advance during 1895.	Percentage of advance during 1895 (fractions omitted).
Atchison, T. & Santa Fé	3½	Jany.	7⅝	4⅛	118%
Balto. & Ohio	49	Mch.	62	13	27%
Ches. & Ohio	16	Jany.	22⅝	6⅝	41%
Chi., Bur. & Quincy	69	Mch.	81	12	20%
Chic. & No.-Western	88	Mch.	99	11	13%
Chic., Mil. & St. Paul	54	Mch.	67	13	24%
Col., Hocking Valley & T	16	Jany.	26	10	62%
Denver & Rio Grande	11	Jany.	15¼	4¼	40%
Illinois Central	82	Jany.	97	15	18%
Lake Shore & M. S	135	Jany.	146	6	....
Louis. & Nashville	47	Mch.	58	11	24%
Missouri Pacific	19	Mch.	28	9	47%
New York Central	93	Mch.	101	8	9%
Norfolk & Western	2	Mch.	4	2	100%
Northern Pacific	2½	Jany.	5½	3	120%
Phila. & Reading	7½	Mch.	19	11½	153%
Texas & Pacific	8⅛	Jany.	12½	4⅜	54%
Union Pacific	7¾	Mch.	14⅛	6⅜	82%
Wabash	5⅜	Mch.	9¼	3⅞	72%

We may for a moment turn aside from the general subject of the all but universal advance, to notice an interesting fact shown by the last column in the above table. There is not so great a difference between the stocks named as to the advance in points, but the percentage of that advance varies greatly, being by far the largest in the low priced shares. We have here an explanation why low priced shares are favorite purchases for speculators when a "bull" movement has begun. Money put into Norfolk & Western or Northern Pacific common stock for illustration was more than doubled ; the same sums used to buy Chicago, Burlington & Quincy yielded a profit of 20 per cent. only, while the profit in Lake Shore was infinitesimal in comparison.

So complete a revulsion in feeling, following the gloom of February, is due in part to the work of the Morgan-Belmont syndicate ; in part to the natural sentiment of mankind, which leads people to feel more hopeful in the spring of the year when nature's life is reviving; and in part also to the unmistakable signs of a gradual return to a normal volume of business in manufacturing and trading.

This is, indeed, only another way of saying that the advance is anticipatory,—that Wall street has, in financial parlance, "discounted" the future; yet the phrase is worth a little discussion. It implies the belief on the part of Wall street that general business will slowly improve, and that the railroads will share in the improvement. As to the probability of a larger volume of commerce, the opinion is general that Wall street is correct in its surmise. The United States, for two long years, has been settling down to a low level of prices, profits, and mercantile credits. The fact that mills are starting up and other enterprises, old and new, are resuming or beginning new work, even though not in full, is evidence that the volume of business will ere long increase. It is true that the margin of profit is small, and that it may continue so for a while; yet a beginning has been made, and a large return to our industries will follow in time.

All this means a larger volume of traffic to our railroads. The shelves of the country stores are, in general, bare of goods, so that at a slight demand a better movement in supplies and manufactured goods will set in. Very much will depend upon the fall crops; yet even in this respect Wall street, with its usual swing, thinks that there is nothing now to fear. Almost everybody is looking for a carrying-trade next autumn which will give all the railroads plenty to do. It is also probable that freight rates, now so low under "cutting" and the force of circumstances, will be higher then. Not that the printed schedule will be changed,—grain and cotton are being grown at too small a profit for that,—but that the printed rates will be more generally maintained. Competing carriers always fight hardest for a volume of traffic which is not enough to "divide around." A small advance in the average rate received, and an increase in the quantity carried, would, as everyone can see, give larger gross earnings as well as an advance in the proportion of profit, so that some jubilation is clearly admissible. And if, in addition, we look further ahead, and, arguing from the past, think what an active and intelligent people may accomplish in a land whose resources are far from being exhausted, it is but fair to say that the expectations for the far future of financial speculators (using the word in its good sense) have a substantial basis.

But there is another side to this picture. In the United States no single industry has suffered as much as that of the railroads for the past two years. Perhaps upon this point it is better to quote the official language of the Inter-State Commerce Commission's statistician. In his preliminary report for the year ending June 30, 1894, he remarks as follows:

> On June 30, 1894, there were 156 railways in the hands of receivers, of which 106 passed into the hands of receivers during the year ending June 30, 1894, and 28 during the year ending June 30, 1893. The mileage of road operated by these defaulting companies is 38,869.96 miles. Eighty per cent. of this mileage is accounted for by 28 important lines. Of the 128 remaining, 59 were small lines of less than 100 miles in length, some of them being parts of larger systems, and some being lines still in process of construction. The total capitalization of roads in the hands of receivers was about $2,500,000,000, or about one-fourth of the total capitalization of the country.

Since January 1, 1895, two railroads, the Norfolk & Western and the Ohio Southern, have confessed insolvency. Thus something more than one-quarter of the railroad companies in the United States have during the past two years been more or less embarrassed,—a very large proportion when compared with the number of business men who have failed, which was something less than two per cent. of the whole number. It is not the purpose of this paper to discuss the reasons for this large percentage of failures in the railroad industry, but merely to note the fact, with some comments upon the results for the present and probable future. To set the situation down in actual figures, there is no better way than to make use of the statistics of the Inter-State Commerce Commission again. Below is a table of income and disbursements, calculated per mile, for three years, from the commission's reports:

U. S. RAILROAD INCOME ACCOUNT PER MILE.

	1892.	1893.	1894.
Passenger earnings..................	$2,104	$2,120	$2,067
Freight earnings.....................	4,946	4,906	4,132
Other earnings..	163	164	151
Total gross earnings..................	7,213	7,190	6,350
Operating expenses..................	4,809	4,876	4,302
Income from operation...............	2,404	2,314	2,048
All deduction for fixed charges, less "other income."..................	1,690	1,660	1,837
Net income..........................	714	654	311
Dividends paid.......................	628	606	418
	*$86	*$48	†$207

* Surplus. † Deficit.

These figures are for the government years ending June 30. In the year ending June 30, 1894, the effects of the business depression are plainly visible. Although the total amount of dividends paid was reduced one-third, the average result was a deficit of $207 per mile ; in short, but $104 per mile was earned in that year for the shareholders, as compared with nearly six times that sum in 1892 and 1893. It is to be feared that, when the statistics for 1895 come to be compiled, they will, as a whole, present even worse results than those of 1894. But, since the last months of this fiscal year show increases in gross earnings generally, there is every hope for the future.

The items in this table, "all deductions for fixed charges less 'other income'" need a little explanation. The preliminary report for 1894 does not give this information, but we have the details for the two previous years :

STATEMENT OF DEDUCTIONS PER MILE.

	1892.	1893.
Interest on funded debt	$1,478	$1,475
Rents	629	632
Taxes	209	215
Interest on current debt	49	47
Improvements paid for from revenue	25	17
Other payments	174	155
	2,564	2,541
Credit by "income from other sources"	874	881
Deduction as per table given above	$1,690	$1,660

The item of taxes per mile could scarcely have been less in 1894 than in the previous years, and was very likely more. Taking the item as $215 per mile, we have the rather startling result that the taxes paid by the railroads on the average in 1894 were twice the amount earned in dividends per mile, and were but one-third less than the total called "net income." Moreover, taxes, whether chargeable to operating expenses or not, are not payments on capital account; hence the sum named for 1894 as "income from operation" is stated at too high a figure, if by that term we mean the amount which capital in one form or another appropriates to itself. Neither should improvements paid for from revenue be included under that term so defined. Altogether the sum earned from operation in 1894 was small, and, being given per mile, is independent of the question of "water" in the capitalization.

Extending our gaze from 1892 to the close of the fiscal year ending June 30, 1895, we know that a number of those companies which have escaped insolvency, or which have continued dividends, have succeeded in so doing only by heroic remedies. Equipment has been neglected, the road-bed left to deteriorate under inadequate care, and, in short, the plant has fallen—in some cases fallen greatly—behind the standard. To bring this plant up to the former level, and indeed to carry the anticipated heavier traffic at all, money must be spent, and spent liberally. Those companies which can afford it—and this is one of the advantages of capital or credit—will take advantage of the prevailing cheapness of material, and begin at once to repair cars and engines and to replace worn-out properties, knowing well that the same work next year will cost them 20 per cent. more. The new money which will in all probability be thus spent by certain of our best companies will give additional orders to rail mills, to car shops, and to supply-men generally. The beneficial effect of such expected expenditures upon general business will be important, for the severe curtailing of railroad orders has borne most heavily upon a worthy class of manufacturers who in times past depended largely upon railroads for the sale of their product. The depression in volume of trade which we have been experiencing since 1892 has been caused in no small degree by this compulsory stoppage of orders and discharge of employees on the part of our largest industry. We are apt to forget that from 1880 to 1890 there were built in the United States approximately 75,000 miles of new railroad. If we consider what this means,—how many tons of rails, how much material, how much land purchased, how many laborers employed in construction, how much food for these men, how much revenue to the older railroads which carried breadstuffs one way and rails and all kinds of supplies the other,—if we consider all this, we shall be the better prepared to put the prosperity of the railroad industry high on our list of causes of general good times, and the more willing to look forward hopefully, if we believe that these same railroads will once more be justified in spending some of their money for construction of new lines or reconstruction of old ones.

That something of this kind will happen on the better class of roads, we may believe. But about the majority of companies—how will it fare with them? That question cannot be answered easily. Many a company which sees the opportunity plainly enough will have no money to spend, even to anticipate the autumn requirements or those of the future. Such railroads ought to spend this money before they earn it. In a majority of cases the losses of 1893 and 1894 (including the required replacement of equipment and property) will probably be funded into bonded debt by the issue of new mortgages or by the sale of old bonds from the treasury. In time, if things are again prosperous, that increase in funded debt can be practically made up out of earnings by taking from those future earnings, if the company will, and putting into the property the sums thus formerly transferred under stress from income to capital. It is at this point that the advance in Wall street quotations will prove important, for it will in time allow the roads pressed for money to sell their securities at fair prices and to apply the funds thus obtained to the repair of equipment, when needed, or in anticipation of that need. Those companies which for any reason have not this resource must suffer the attendant disadvantages.

It is probable that our railways, as a whole, will be operated somewhat more cheaply in the immediate future than in the past. The prosperity which was ours up to 1893 was not conducive to economy, at least, not to that kind which requires careful study both of broad plans and of details. "Sweet are the uses of adversity," and in the present case adversity has taught us points in the economics of railroad-working hitherto unexpected. Some of these points have already been well treated in the ENGINEERING MAGAZINE. But one possible source of future economy has not been widely discussed, and may well be mentioned now. I refer to the necessity for a reduction of grades. The lading of the train has only lately received from railroad officers the attention it has merited. The engines, it is safe to say, are now hauling loads which are nearer to their theoretical capacity than ever before. But on many roads that capacity is still seriously limited by the gradients. It may be that on a division there is a governing grade and perhaps but one, which limits the number of cars hauled over the whole division, or at least necessitates the use of a pushing locomotive. Why are not such grades removed? The railroad officers know the situation well, and very likely the chief engineer has prepared tables, based on the average movement of trains, which show that the cost of removal of such grades would be made up in a few years by the saving in operating expenses. The reason why such recommendations are not followed is, of course, the lack of capital. But, if railroads are to be again profitable, and if we believe that freight rates in the United States are to be regarded as permanently on a low plane, it will only be a matter of time when questions of this character will become burning ones. Assume for a moment that normal business is once more with us; assume also that the companies have been obliged to put back into the property the money taken from it by a "forced loan" during the depression; assume that this loan has been transferred to the public by the issue of bonds sufficient to cover the expenditure,—a thing which the recent advance in prices may render possible; assume all this, and we still have a question before us of the first importance. Will the margin of profit support the capitalization, including the new issues, and at the same time allow the keeping of the property at the required standard? It is a question which only the future can answer. A great deal will be done in this direction by the economies in operating already mentioned, but will these go far enough to accomplish the purpose? Time alone can tell.

If the answer to this question should turn out to be adverse to any considerable number of railroads, it is not impossible that, as a result, we shall be found entering gradually upon a new era in railroading. More and more in all lines of business are we realizing our dependence upon credit and capital. As manufacturing tends to become centered into larger corporations, so it may be with the railroad industry. Additional capital to cut down grades, and in other ways to reduce operating expenses, may become a necessity; while at the same time perhaps through those who deal in capital on a large scale the means may be found by which harmony may be secured between the warring companies. To call such a nebulous plan by a name would be to confine a mere thought within limits. Consolidation has a definite meaning, and might be difficult to carry out. If it should happen that cutting of rates and reduction of revenues should go on until the weaker roads were nearing exhaustion; and if also a union of capitalists should allow of help in some form at such a juncture,—we may see a marked change in the general situation. Meanwhile, the advance in the quotations on the stock exchanges expresses the general confidence of the public in the ultimate future. Speculation accounts for the fact that the cheapest shares have had the greatest rise. The next stage, at some time in the future, must be discrimination between one company and another or one security and another, depending upon the outcome as to the margin of profits in each particular case after normal conditions, both as to property and as to traffic (though not necessarily as to rates), have been restored. If that margin of profit is found sufficient, things will go on smoothly; if found insufficient, then some remedy, perhaps on the lines already suggested, will be found.

THE CAR-BUILDING INDUSTRY OF THE UNITED STATES.

By John C. Wait.

THE subject of car-building is not one that appeals to the interest of the general public. It has no such significance as the industry of ship building, and no such importance is attached to it by the people. An act of congress to promote the car-building interests of the country, for example, would be a decided innovation.

The reasons for this are several. One is, no doubt, that a car is a common-place object familiar to all, especially an ordinary freight-car. On the other hand a ship is a small universe of curiosities,—an object of profound admiration because of its colossal dimensions and the dangers through which it passes. A car has no traditions enveloping it, no legends surrounding it. With the navy the people are wont always to associate the protection and preservation of our country. But never a thought is given to the wonderful part that a freight-car may play in the mobilization and supply of an army. Yet, in case of invasion of our territory, the vehicles of war that would save the nation would be these same despised freight-cars, and an industry that would figure quite as much in the preservation of our country as any other would be the car-building industry.

A brief, but careful, consideration of the relative importance of the two industries mentioned may create a different sentiment among the people. In 1890 there were 1010 shipbuilding establishments in the United States with an aggregate capital invested of $53,393,074, employing on an average 25,934 employees who received $16,028,847 in wages; while for the same year 882 car-building and car-repair plants represented a total capital of $124,653,164, gave employment to 144,514 persons, and paid $81,243,363 in wages. The car-building interests represented twice the capital, employed five times the number of persons, and paid five times the aggregate wages. The impression of the magnitude of the individual ship-building establishment created from association with the government navy-yards and the Cramps' ship-building plant, needs to be corrected by knowledge of the fact that the average value of the ship-building plants of the country, including land, buildings, and machinery, is only $394,158, while that of the average car-building plant is $861,054.

The cost of materials used in ship-building was $16,925,109, and the value of the product, including repairs, was $40,342,115; while the materials used in the construction and repairs of cars amounted to $114,090,087 and the manufactured products turned out were valued at $205,813,897.

In 1893 the tonnage of the transatlantic steamships combined was about 2,250,000, while in the United States and Canada there are over 1,340,000 freight-cars with a tonnage estimated at more than ten times that of the transatlantic steamship companies. In the face of these facts and statistics, it is difficult to understand how anybody can fail to appreciate the importance of one of the largest industries of the continent,—an industry that ranks sixth among the mechanical and manufacturing industries in the number of employees, eleventh in the capital invested, and tenth in value of products.

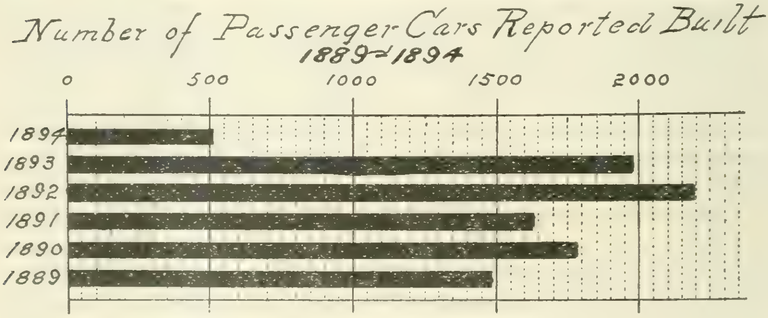
Previous to the year 1893 car building had long enjoyed a very profitable business. One company began in 1849 with $10,000 cash and a tract of land valued at $10,000 ; after 42 years of business, and without any additions to the capital from any extraneous source, owned property worth nearly $3,500,000, exclusive of surplus profits arising and paid in the regular course of business. The profits for the 6 years and 1 month ending July 31, 1891, amounted to $2,321,163, or a yearly average of considerably more than 12 per cent. The assets of this company on December 1, 1893, were $5,224,178, and its plant comprised 28 acres and 40 buildings, and employed nearly 2000 men.

One of the largest freight-car-building establishments reported has a plant which comprises 83.5 acres, and 78 buildings, employs 5000 men, has a capacity of 100 cars per day. The total assets of this company in 1893 were estimated at $11,000,000, and it paid earnings amounting to $1,062,382, or nearly 10 per cent. of the investment. A third company reported in 1893 a total investment of $2,500,000 and a yearly output of $3,000,000. It employs 2000 men, and has a capacity of five passenger- and twenty-five freight-cars per day.

These three companies may not faithfully reflect the prosperity of the industry, as a whole, but they do show that car-building for many years has been a profitable business, and that the growth of some companies has been almost phenomenal.

Until 1893 the car-building companies were fully able to take care of themselves, but since then the market has been at its lowest ebb. In 1890 there were 71 car-building companies engaged in making steam-cars, not including railroad shops. These companies had a total capital of $43,641,210, of which $3,811,086 was invested in land, $7,878,189 in buildings, $7,626,804 in machinery and tools, and $24,325,131 in live assets. The number of men employed was 32,062 and the wages paid $16,836,531, or $1.70 per day,—306 days to the year to all employees. The cost of materials used was $44,674,486, and the output $70,083,737.

The accompanying diagrams (pages 682 and 683), show the number of companies which reported their business to the *Railroad Gazette* for the years 1889 to 1894; these companies represent probably 90 per cent. of the annual product of the country. The diagram shows that, for 1889, 40 of these principal companies built 130,881 freight-cars and 1484 passenger-cars. For three years thereafter bountiful crops and the Columbian Exposition kept the industry alive, and nearly 100,000 freight-cars and from 1500 to 2000 passenger-cars a year were built. In 1893 only about one-half the number of freight-cars were built. The effect of the World's fair on passenger-car work, in keeping the product almost up to the 2000 mark, may be seen in the diagram. The drop from 100,000 freight-cars in 1892 to 17,000 in 1894, and from 2000 passenger cars in 1893 to 500 in 1894, is also shown by the diagram, as plainly as words can express it. It may be added that one-third of the steam-car-building plants that take contract work have been shut down.

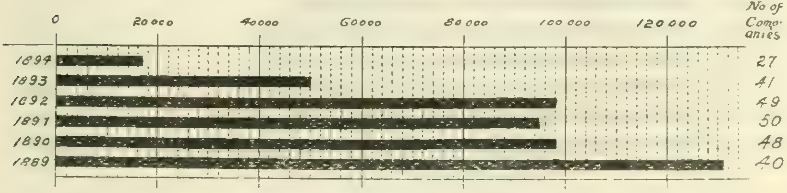


Probably at no time in the history of our country have the shipbuilding interests been so depressed as have the car-building interests during the past year. The fact that our car companies have had business for many years and have done it at a profit augurs well for the future. They have not only supplied their own country with cars, but entered into competition with European countries for foreign car work; and, where the competition has been free, American cars have taken precedence. It required only a careful study of the cars exhibited at the Columbian Exposition to convince even an Englishman of the superior class of work offered by our car companies, and Americans may well take a native pride in the fact that our railroad equipment is unexcelled by any in the world, either in design or quantity.

The leading military and railway nation of the Continent, Prussia, in 1892 had but 205,476 cars, of an estimated tonnage of 1,233,000 tons, each car being of one-fourth to one-fifth the capacity of American cars. In 1891 Russia had but 7,788 passenger cars; in the U. S. there are nearly five times that number. If the car equipment is in proportion to the mileage of the railroads, America may well feel herself proud. The total mileage of the whole world is estimated at 406,416 miles, of which America has 218,910 miles, excluding side tracks and sidings. The United States alone has 228,852 miles, if the side tracks and sidings are included, and the elevated railroads of New York are omitted.

To fully appreciate the magnitude of the car building industry let us inquire what it includes. It includes, first, the erection of from 60,000 to 120,000 cars a year, and the repair and renewal of parts of about 1,400,000 cars that are in almost constant service. It includes the manufacture and supply of all the couplers, draft-rigging, wheels, axles, brasses, doors, and roofs, and for passenger cars a multitude of furnishings, including lamps, seats, heating and lighting apparatus, brakes, and vestibules.

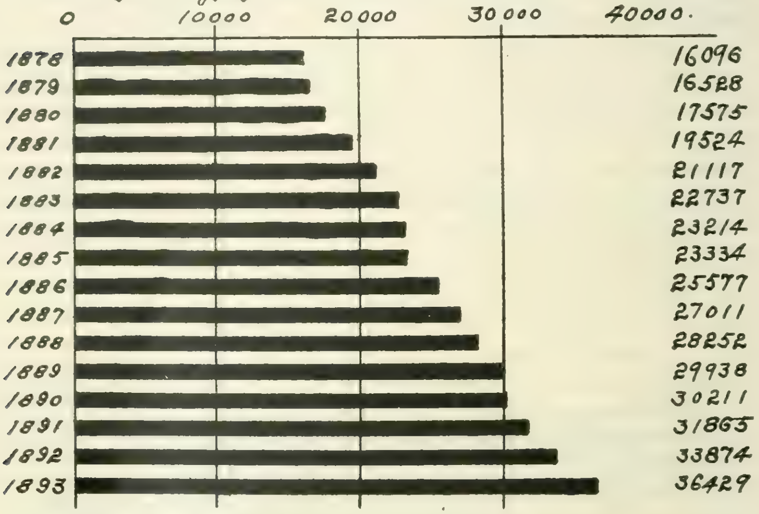
Number of Freight Cars Reported Built 1889–1894.



In January, 1895, the aggregate number of cars in service in the United States and Canada was, (see pages 684 and 685), about 1,406,321, of which 1,208,770 were included in the equipment of railway companies, 164,987 were in the service of transportation companies, and 32,564 belonged to private companies or individuals. This equipment represents an investment of not less than $750,000,000, and requires for repairs and renewals a sum approximating, $70,000,000 per annum. To do this re-building and repairing requires 100,000 men, who receive $1,500,000 per year, and, though generally classed as car-repairers, may certainly be considered as belonging to the car-building industry.

The renewals alone require the annual production of about 1,500,000 wheels, 175,000 axles, and of course an immense number of journal bearings, springs, bolts, and iron parts worn out or broken.

A still better comprehension of the countless number of cars may be had when it is considered that they would make two continuous trains or structures reaching from Boston to San Francisco, and that, in time of war, our government could establish with the rolling-stock at hand a continuous train of cars running both ways across the continent with a locomotive to every forty cars. Such a transcontinental train would not include several hundred thousand or more of street and suburban cars, of which there are some 54,000, including motors, in the State of New York alone.



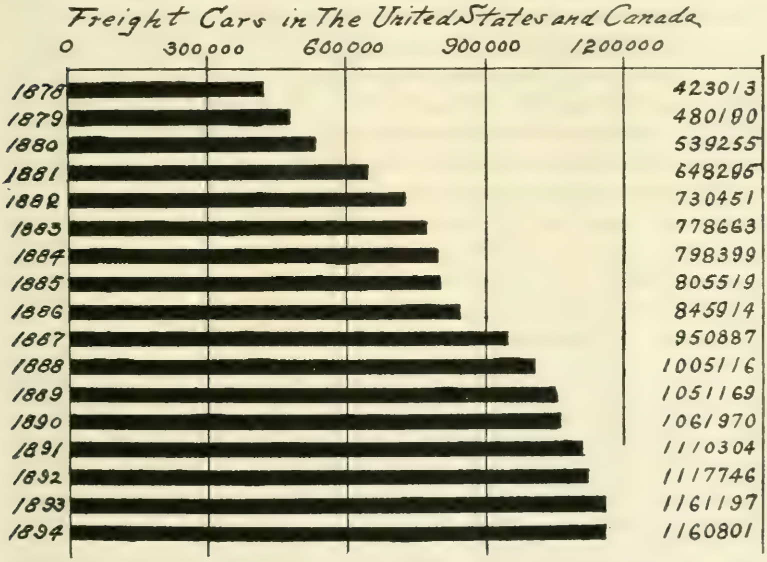
Passenger, Baggage, Mail, and Express Cars in Service.

The chief car-building plants, and indeed the bulk of the car-building business, is carried on in the middle and central States within the territory bounded by the cities of Chicago, Detroit, Buffalo, Troy, New York, Philadelphia, Huntington, W. Va., Cincinnati, and St. Louis. In 1890 about 75 per cent. of the cars built in the United States were built within these limits, and it is estimated, after careful inquiry, that fully 90 per cent. of the cars built in the past year were built in this territory. This is due chiefly to the fact that this is the manufacturing district of the land, but also to the fact that fully 65 per cent. of the equipment owned by railroads and 75 per cent. of the total equipment of the country are owned or controlled within it.

The car companies which best endured the panic of 1893–4 are those located in the large coal, iron, and lumber markets or in close proximity to the fields supplying these materials of construction. Coal at 90 cents or coal at $2 ; iron at the furnace or rolling-mill, or iron from the merchant, or with transportation added ; lumber by the raft, at the dock, or out of the yard,—these things very quickly decide the lowest bidder in a close competition.

An important, yet secondary, factor is the labor, its ratio to that of the whole cost of a car being about one-eighth. Its cheapness depends largely upon the location. Car shops generally are near large cities, where skilled labor can be had at short notice. To cheapen the cost of labor, car companies and other large manufacturing interests have purchased large sites in isolated and unimproved sections near large cities, and established their plants where house lots and living may be had at a minimum cost. Labor so situated is expected to be content with less wages, to the profit and advantage of the company employing it.

The most familiar of such car-building settlements is that of the Pullman's Palace Car Company at Pullman, Illinois, where the company enjoys close proximity to rolling mills and the great lakes lumber district, and has direct connection with a dozen different railroads leading to coal and coke fields. There are several such plants in the country, one of the largest being that of the United States Rolling Stock Company at Hegewisch, Ill. The Canda Car Company at Carteret, N. J., The Harvey Steel Car Company at Harvey, Ill., and The Union Car Company at Depew-on-the-Hudson, are plants recently established after the same plan. A plant so established can better afford to take work at an unprofitable price than to have its houses vacant or let the town go to decay.



To such proportions has the supply business grown that the car builder has become little more than an erector, instead of the manufacturer which he was originally. It happens not infrequently that the work of the car company consists in furnishing the wood and iron work and doing the framing and forging, and it is not unusual for a railroad to specify the parts so explicitly that the car-builder must procure them from a particular source, when the advantage of a central location is apparent, saving time and expense.

The chief and distinguishing feature of American cars is their large size, the capacity of our new cars being from three to five times that of European cars. In 12 years the capacity of freight-cars has been increased by one half, and this growth in capacity has required corresponding changes in detail, so that the establishment of standards has been well-nigh impossible.

Motive-power superintendents and master car builders now feel that cars are large enough, and that more is to be gained by railroads in adopting standards and standard details than can be gained by further increase in the size of cars. Whether they will have the determination of this important question seems doubtful. Transportation companies and large shippers who furnish their own cars, which are hauled by the railroads as a car, find cheaper rates in larger cars, and an increase of a few tons in the capacity of a car means a very large increase in the net tonnage for a year. Without any other motive apparent than the gain of tonnage at the expense of the roads, and without any pretence that the operation of heavier cars is any more economical, these companies are urging heavier and larger cars, which shall carry 70,000 to 80,000 lbs., and weigh, when loaded, from 100,000 to 120,000 lbs. The length proposed for such cars is 40 or 42 ft.,—height and depth to be slightly larger than at present. To get the business of these companies, not only do railroads consent to haul large and ponderous cars, loading their track structure to the extreme limit of safety, but the traffic departments are said to be quietly urging the mechanical departments to provide such cars as a bid for the business. If persisted in, this will inevitably result in much larger cars and postpone the adoption of standards.

The only limit to the size of cars will be the limiting cross-sectional area of the tunnels and track structure and the curves of the double tracks. This, as has been shown by Mr. Theodore Cooper, in a paper read before the American Society of Civil Engineers (Proceedings, Vol. 31, p. 174), will be a car about 42 ft. long and weighing not more than 4000 lbs. per linear foot of track. Such a car will weigh nearly 170,000 lbs. In anticipation of such a car, Mr. Cooper suggests that 4000 lbs. be taken as the maximum loading for trains on one-track structures.

The tendency to simplify the construction of cars by lessening the number of parts is growing more pronounced among car-builders and designers. This is shown by the general adoption of the rigid diamond truck in preference to the swing-motion truck. Another tendency is to do away with the multiplicity of parts by making one pattern or shape do duty for several castings. This is illustrated by doing away with rights and lefts of many parts in the same car, and using the same sizes and shapes in several structures, even though they be a trifle too heavy or too strong for some of them.

The long-looked-for adoption of iron for freight-cars has not yet been realized in this country, but it is certainly gaining favor among the mechanical departments. The prejudice that has existed is wearing away, and iron and steel are freely used in the form of flitch plates, reënforcing bars, and angles in both freight and passenger bodies as well as in the trucks. Iron in these shapes is certainly gaining favor, and by the time railroad corporations feel able to pay the extra first cost of iron over that of wooden cars, no doubt the car builders will be in full sympathy with the change. With our repair shops equipped with tools and men for doing iron work, and with a standard size determined, the adoption of iron cars will be assured.

In answer to the question put to the car builders of the country: "What do you consider the prospect for a revival of car building for 1895–6?"; the answers were almost unanimous that the prospects were "*fairly good.*" This feeling must be based upon the assumption that the railroads have ordered little equipment for the past two years, and that they will require new cars to take the places of those condemned or destroyed.

There is other work in sight, too. Of the number of cars owned or operated by the railroads of the United States, given by the Inter-State Commerce Commission as 1,273,946, of which 31,384 are in the passenger service, only 271,367 are fitted with train brakes. This number includes 30,562 passenger-cars, or 97.3 per cent. of the cars in passenger service, and only 20 per cent. of the freight cars. Doubtless this number does not include the equipment of transportation companies, which, as shown by the foregoing table, amounts to 165,000 cars, in round numbers. The Westinghouse Air-Brake Company claims to have its brake in service on 27,000 locomotives and 408,000 cars, which is less than one-third of the total car equipment of the United States and Canada. The application of train brakes will afford work for the brake companies.

The coupler question is one that will require the attention of both car builders and supply men. Only 2½ years remain in which to comply with the legal requirement that the old link-and-pin drawbars shall be replaced by the automatic coupler, on all cars engaged in

Inter-State commerce. As nearly all the freight equipment and a good deal of the passenger equipment are engaged in such traffic, it may be assumed that the change will be complete.

The commission reported in June, 1893, that 318,302 cars were equipped with automatic couplers, and that 30,446 of these were passenger-cars. That will leave, according to their figures, 955,644 cars to be supplied with couplers, to which may be added a great number belonging to transportation companies and to individuals.

The heating and lighting of cars is another subject which will afford car builders considerable care and labor. Legislation is likely to be enacted in all the States which will require the introduction of steam-heating plants. Gas-lighting continues to gain favor, wherever adopted. It is now in use on nearly six thousand cars, or about one-fifth of the passenger equipment of the country.

In looking at prospective work, the pressed-steel industry should not be overlooked, for it has many friends in the car-building circles; nor the steel-tired wheel industry, whose wheels are now applied to about 36 per cent. of the passenger equipment; nor the car roofing companies; nor the car-door business; nor the companies making and furnishing vestibules.

In conclusion, it may be said that, as broad and comprehensive as the subject of car building may seem, there is much that has not been touched in this paper. The quantity of furnace, rolling-mill, and foundry products which it absorbs; the oils, paints, and varnishes applied to its cars; the plushes and furniture used for furnishing; the lamps and the many fittings and appliances necessary to make a car complete,—are not included in the above statistics. The labor employed and the capital invested in the production of these supplies would swell the figures already given beyond all comparison with other industries. Without these the car-building industry of our country should receive the recognition which it justly merits. It needs an occasional depression of railroad business to bring the public to a proper sense of the close relationship which exists between the prosperity of the nation and that of the railroad interests, and of what an important part the car-building industry of the country bears to the railroad interests as a whole.

A GLIMPSE OF "THE SILVERY SAN JUAN."

By T. A. Rickard.

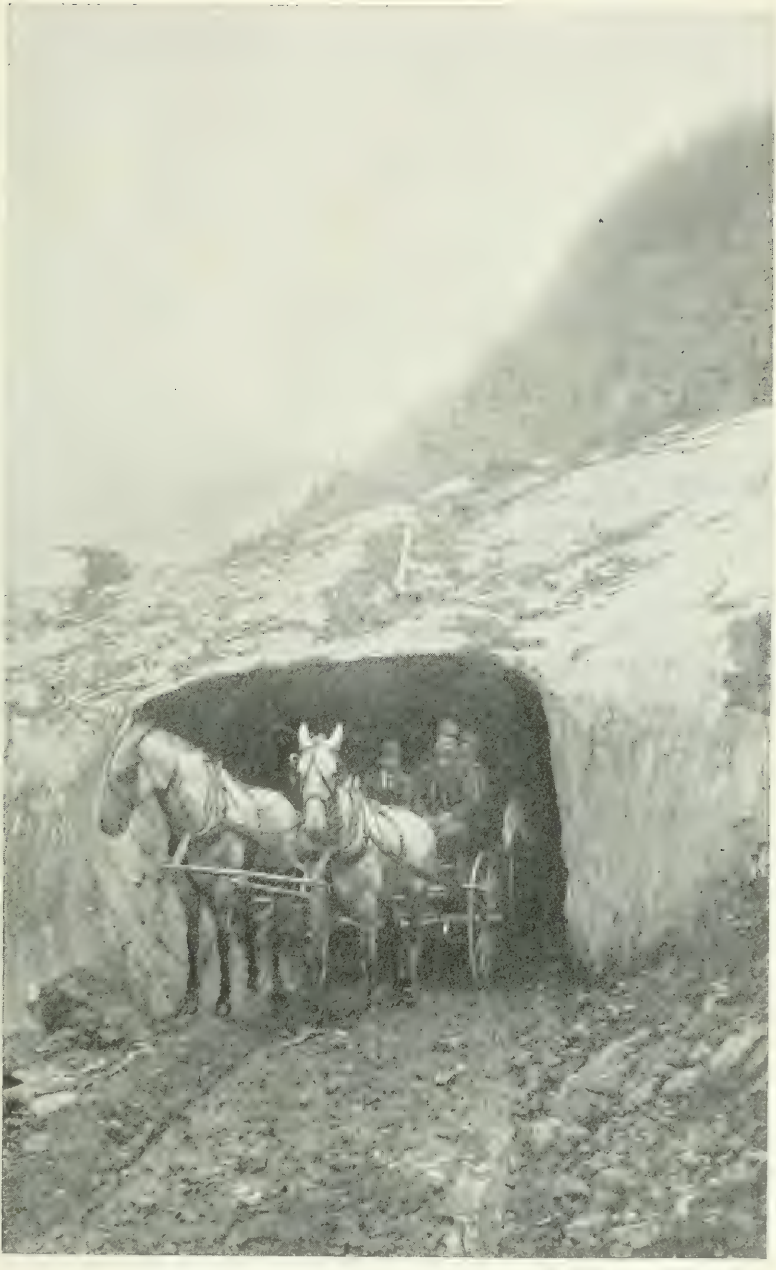
THIS, the most picturesque part of Colorado, forms the southwestern division of the great mining region stretching from Hahn's Peak to the New Mexican border. Though this rugged mountain land is the Switzerland of the West; though it possesses beauty for the artist and wonders for the scientist,—it is nevertheless unknown to many who in their hurried transit from the Atlantic to the Pacific adhere to the main trans-continental lines of travel. Even the citizen of Denver too often knows the San Juan merely as a rich mining district, and has but the vaguest idea of the grandeur of snowy summits, dark ravines, and forest-clad hills which will forever remain as a heritage of loveliness to him and his.

This region was named "the silvery San Juan" a few years ago, when the Yankee Girl, the Guston, the Enterprise, the Rico Aspen, the Smuggler-Union, and other famous mines were sending their daily tribute of gold and silver to the marts of the world. Recent events have given the adjective "silvery" the sound of an unkind cynicism, which is being brushed aside by the renewed confidence afforded by a successful development of gold mines, the output of which is winning the newer name of "the gilded San Juan."

To many the changed direction taken by the energy of the mining communities of this and of other parts of Colorado, as evidenced in the transference of work from silver to gold mining, is a puzzle and a continual wonder; to others it is a fit subject for iridescent editorials and misleading newspaper articles. Silver mining has been for a time seriously crippled. The present production of the State is derived largely from ores wherein the two precious metals are closely associated. When a silver mine is said to have become a gold mine, it is often due, not to any new discovery or wondrous transmuting of the one metal into the other, but simply to the plain commercial fact that the fall in silver has so diminished the market value of the silver contents as to proportionately increase the relative value of the gold contents and render the ore more valuable for its appreciated than its depreciated metal.

Nowhere have the flimsy romance and the stern reality of mining been so strongly contrasted as in the stirring tales that tell the story of

MT. ABRAM—THE MATTERHORN OF COLORADO.



THE DIFFICULTIES OF A MOUNTAIN TOLL-ROAD.

A tunnel in summer through a snow-slide which came down the mountain in spring.

the discovery and development of the San Juan region. Of the great tide of immigration which swept westward after the financial panic of 1857 one wave broke over the Sangre de Christo range and, penetrating the San Luis valley, invaded what is now the San Juan. Tim Baker, scout and trapper, led a party to the headwaters of the Animas in 1861. Baker's park, the site of the present lively town of Silverton, perpetuates his memory. In 1872 mining operations began in earnest. In those days railroads were unknown, and mountain trails few and hard to follow; the nearest smelter was on the further side of two snowy ranges, and transportation, even in good weather, occupied at least 20 days; work was done in the summer months only, and the beginning of every winter saw an exodus to lower altitudes. The San Juan was uninhabitable during half the year, because defective communication rendered it impossible to obtain the necessary supplies, and it was only as the toll-roads penetrated into the heart of the hills that life became bearable or even safe.

In this connection it is interesting to note the remark made in one of the early government reports that the cañon of the Animas below Silverton was impassable to man and mule. That very cañon to-day echoes to the wild shriek of the locomotive, and throws back the thunderous rumble of swiftly-passing Pullman cars. And so we smile at the statement of the government surveyor of 20 years ago. Yet remember that at that time even the cat-like Indian climbed the upper cliffs rather than follow the gloomy defile into which the heedless river rushed. Recollect, too, that the Spaniards poetically called the torrent "Rio de las Animas perditas,"—the river of lost souls,—a name the appropriateness of which you will not deny when you are hidden in the inferno of its wild way between dark, overhanging crags that throw sombre shadows over the inky blackness of its eddies where the waters are stopped in mid career by gigantic boulders and permit brief gleams of sunlight to flit across the swift current in lines of serpentine sapphire. No wonder the redskin, the trapper, and the pioneer, each in turn, hesitated, stopped, and chose the most circuitous pathway over the mountain. But to-day the engineer pulls the throttle, and the railway train plunges down the grade, safe and unresisted, into the Cimmerian gloom, to emerge again into the sunlit beauty of the open valley.

Such is western progress. The impossible becomes the commonplace. Climb with me one of those narrow paths which zig-zag yonder mountain slope, and, when you begin to appreciate the fact that you are at an altitude of 2 miles above sea-level, sit you down, and, while you rest, I will suggest something of the patience and pluck which have brought civilization into this mountain-girdled spot.

MINING UNDER DIFFICULTIES.—CLIFFS ABOVE OURAY.

A WINTER SCENE.—BLUE RANGE, NEAR TROUT LAKE.

And first, feast your eyes with the wonderful coloring of the hills. You may have seen the waves of the New Zealand woodland crested with the white manuka ; you may have been gladdened by the darker beauty of the Australian bush "when the wattle gold trembles 'twixt shadow and shine"; you may have wandered amid the crimson glories of the tropic jungle, or watched the softer richness of New England maple forests when the autumn has thrown upon them its coat of many colors ; but not one of these can equal in superb lavishness of splendid coloring the mountains of Colorado when yellow-haired September has thrown over them the splendors of her red and gold. And in September, too, when the fall rains have been followed by the first frost, the landscape has an atmosphere and the earth a radiant beauty which is more rare than the insipid freshness of early spring.

And then, as you look down into the valley which stretches in noble perspective between the many-buttressed mountains, you begin to realize the fact, previously lost in the immensity of the view, that the rocky covering of these rugged ranges is as full of life as an ant-heap. Far up on the opposite cliffs you see a long line of pack animals descending in single file along a narrow pathway overlooking a ravine into which the sun but rarely penetrates. They are laden with sacks, containing ore. Further down another similar train of burros (or donkeys) comes slowly in the opposite direction. They, too, are laden, but with supplies, among which you would find canned vegetables, iron nails, sacks of flour, dynamite, a pair of blacksmith's bellows, etc. If you were nearer to them, you would wonder at the sure footed, patient little beasts, with a look as demure as a school-girl's, and you would be startled by the magnificent polyglot fluency of the driver, whose shouts echo down the cañon and mingle with the unceasing voices of the torrent.

Look down the main valley, and you will distinguish the red roof of a stamp-mill, whose muffled thunder is rendered faint by distance. It is connected by a fairly straight, but dusty, toll-road with the town, whose clustered dwellings you dimly see at the foot of the range. There is also, you will note, another road, connecting the mill with the mine, but it is rarely used now that its winding length of 3 miles is replaced by a straight aërial ropeway connecting the ore-house at the mine with the ore-bin at the mill. Along the tramway, small buckets, each having a capacity of 150 lbs. of ore, are continually coming down full and returning empty. Down the main road a big wagon drawn by six horses is lumbering along, half obscured in golden clouds of dust. And as your eye wanders ahead, you see the regular perspective of telegraph poles, and you become conscious of an even line

RICO, AND THE ENTERPRISE GROUP OF MINES.

SILVERTON, AND KENDAL MOUNTAIN.

NEEDLE MOUNTAINS FROM ANIMAS CAÑON,

which marks the railway grade, and, while you look, a silver wreath of smoke shows the swift rush of the iron horse.

Here is the evolution of the transportation of a mining region from the uncertain burro-trail to the graded wagon road; from the winding road to the direct tramway; from the tramway to the completed railway system, linking the life of the mountain hamlet to the mighty tide of commerce which sweeps across the seas.

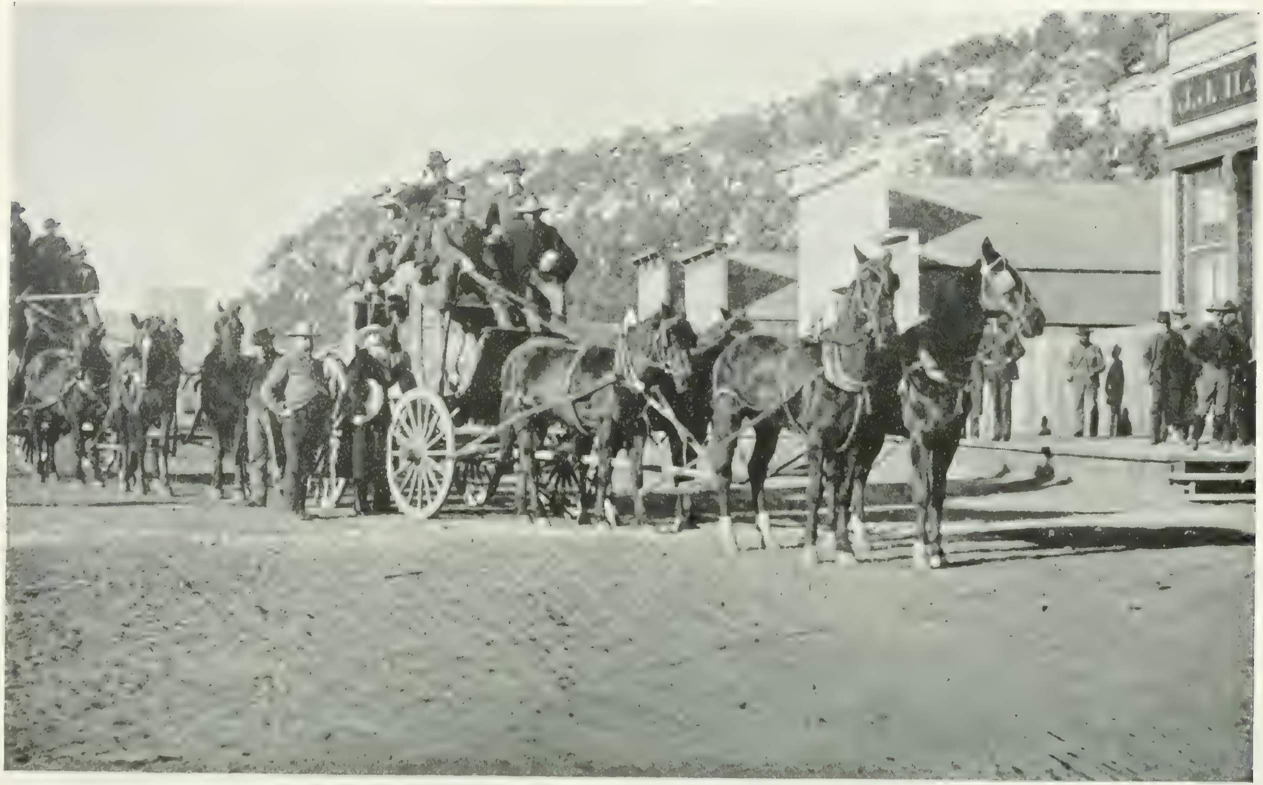
In the San Juan this evolution has been accomplished in less than a generation. The men who picked out the first mountain pathway are yet alive; the engineer who built the tramway now directs important industries; and "the pathfinder of the San Juan," as its most successful pioneer has been aptly called, has ceased building toll-roads, and become the president of a railroad which his restless energy caused to be constructed.

Something of this story may be briefly told. It begins with the building, in 1867, of a toll road from the San Luis valley westward across Poncha pass. This road was built for the particular purpose of freighting supplies to the gold diggings at California gulch.—afterwards Leadville. It was 110 miles long, and was constructed on a gradient such as a railway might follow, because its projector even at that time had a vague idea that it might prove to be the forerunner of greater things. In 1872 the discoveries made in the country further south led to the commencement of a road from Saguache in the San Luis valley across the range to the Lake fork of the Gunnison (now the site of Lake City), and in 1873–4 this road was continued across another range to Howardsville, the pioneer of the present town of Silverton. This was the first road into the San Juan, and was similarly constructed on a railroad gradient.

In building the road to the Lake fork, the foreman in charge, a man named Enos Hotchkiss, discovered a cropping of ore, and located a claim to which he gave his own name. The Hotchkiss mine had a chequered early history, and was abandoned at intervals until the last 3 years, when, under the name of the Golden Fleece, it was found to contain a body of ore which has made it one of the richest mines in Colorado.

In 1873 rich lodes were found at Ouray. A toll-road was begun from the Lake fork to reach Ouray by way of Indian creek. In 1884 certain gold veins began to be developed on the other side of the Mt. Sneffels range. A wagon-road was constructed from the Uncompaghre to San Miguel, just below the present town of Telluride. In the same year the last-named road was continued over the divide down the Dolores river to Rico.

Each of these toll-roads followed pre-existing Indian trails, and,



ABOUT TO LEAVE OURAY FOR RED MOUNTAIN.

as already stated, in laying them out, there was kept in view the possibility of future railroad construction.* That dim possibility has become a bright reality. Thus, therefore, the untutored mind of the redskin laid down the plan of the railroad system of the San Juan, he in turn following the lines which the frost and the sun, silent sculptors of nature, had hewn out for generations untold.

The building of these roads was no child's play. Often the workers had to be suspended by ropes along the faces of precipitous cliffs while drilling holes for blasting. Even afterwards the hauling of heavy machinery over the mountains was accompanied with much danger. The wagons had to be held back by attaching fine trees to them, or were let down the steep grade with the assistance of rope and tackle. The predicaments into which people got, the mingled danger and amusement, the delays and the accidents which befel the early pioneers, make tales which are as full of quiet humor as of reckless daring.

The commercial aspect of the changed methods of transportation can be suggested by a comparison of the manner in which, at various periods, ore was sent from Silverton to Pueblo.

In 1876 the ore was carried by burro-train to Del Norte and by wagon from there to Pueblo. The cost was $80 per ton.

In 1880 it went by wagon to Alamosa and thence by rail to Pueblo, at a cost of $50 per ton.

In 1881 it was forwarded by wagon to Durango and thence by rail, for $30.

In 1882 the railway took it all the way for $16 per ton. In 1895 the freight rate is $8.00 on low-grade, and $9.00 per ton on higher-grade, ore.

To these notes may be added the statement that it took ten burros or seven mules to carry a ton-weight of ore, that a wagon held from 2 to 4 tons, and that a freight-train is composed of from five to fifty cars, equivalent to a load of from 50 to 500 tons, the minimum figure in the latter case being required only on occasional heavy up-grades, and the maximum permitted only on similar down grades. Thus the cost diminished from $80 to $8 per ton, while the quantity transported at one time increased from 2 or 3 tons to 200 or 300 tons.

If such, then, be the kaleidoscopic changes in the picture which portrays a part of the progress of this mining region, would you wonder at tales of extraordinary luck and endless vicissitude which tell the more immediate story of the mines themselves? And yet, believe me,

---

* Mr. Otto Mears was the builder of these roads. To his early enterprise and energy, and to the later business sagacity of the general manager of the Denver & Rio Grande Railroad, Mr. E. T Jeffery, the San Juan owes more than this brief note can tell.

BURROS PACKED FOR THE MOUNTAIN CLIMB.

there has been less luck than is supposed, and more good sense, coupled with dogged perseverance; there has been less of wild speculation than you would think and more of skill and enterprise than is told to you in the apocryphal yarns of the hotel lounger.

Take, for instance, the story of the Enterprise mine, at Rico,—a property which has contributed its share of that small amount of gold and silver upon which the shaky superstructure of the world's commerce is built. Rico is across the range from Silverton, and was first visited by the pioneers in 1864, at the time when a guide named Robert Darling brought a party of United States army officers and some Mexicans from Santa Fé to see the cropping of certain lodes which he had found on the Dolores river. In its early days the camp had a very uncertain career, unmarked by important discoveries, until the finding of ore on Newman hill, by Harry Irvin, in 1879, led to the development of the deposits lying at the foot of Mt. Dolores. At first operations were mainly confined to the claims belonging to the Swansea Gold and Silver Mining company. In 1881 a shaft was sunk by David Swickhimer and his two partners upon a claim further north, called the Enterprise. The intention was to sink this shaft so as to intercept the veins which were being at that time so successfully worked in the Swansea ground, it being expected that their extension would be found beneath the drift, consisting of boulders and gravel, which in that part of the hill overlies the surface of the true rock encasing the ore-bearing veins. In 1883 this shaft was abandoned. In March, 1887, Swickhimer resumed the sinking, having become convinced by an examination of his neighbors' mine that the veins which they were successfully working would extend into his ground, and that, unless he soon reached them through his shaft, he would find it difficult to maintain his title to the claim. Many obstacles were encountered; bad luck and want of sufficient experience were added to a heavy inflow of water, which again and again nearly compelled the abandonment of the undertaking. Funds ran out, and the cessation of work seemed imperative; but just at this time Mrs. Swickhimer won $4000 in a lottery, and promptly contributed it to the helping forward of the development of the mine in which she and her husband had a common interest. On the 6th of October rich ore was struck in the shaft at 262 ft. from the surface, the judgment of Mr. Swickhimer was confirmed, and he began a highly successful career. The mine at once became the scene of very active development, and in 1892 was sold for a sum which approximated a million dollars.

This is a tale of logical good sense backed by the same sort of pluck and perseverance that have built the railways across apparently impassable mountain ranges and changed the Great American desert into the granary of a continent. Instances such as this might be multiplied. It is too often supposed that, because some drunken fool lights by accident on a nugget of gold or stumbles against the outcrop of a silver vein, therefore mining is the sport of a blind and fickle fortune. There is as much luck in mining as in any other business enterprise, hardly more; there is as much room for skill and sense in mining as in other commercial undertakings, and a good deal more. Whenever this is properly realized, the industry will be ranked with agriculture as one of the two most beneficent occupations of a busy humanity.

THE ROYAL GORGE.

THE MODERN RAILROAD MACHINE-SHOP.

By H. D. Gordon.

THE remarkable economies that have been effected in the operation of railroads since their institution, as well as some of the directions in which further reductions can be made, have been ably presented by Mr. L. F. Loree in the papers published in recent numbers of the ENGINEERING MAGAZINE. The subject is very interesting to those who are responsible for the proper and economical management of the various divisions and sub-divisions which constitute the organization of modern railroads.

Among these departments there are none that contribute more to the efficiency, popularity, and profit of railroads than the mechanical department.

It is, of course, true that each is dependent upon the others for a thoroughly successful operation of the whole, but, however perfectly organized and well managed the others may be, if the mechanical department has not properly performed its duties, and the motive power and cars have not been provided or are inefficient, then the business cannot be carried on.

There is no factor of the mechanical department that contributes more largely to its efficiency and economy than well-equipped and well-managed shops.

Mr. Loree says: "By the use of up-to-date tools, and the convenient arrangement of the work and materials, considerable reductions can be made in the cost of repairs. By such means the cost on 170 engines of repairs averaging $926.61 each, at one shop during the past year, was reduced 10½ per cent."

If, then, such economies can be effected by the introduction of modern ideas and appliances in our railroad machine-shops, is it not the duty of those in charge of the mechanical department to give serious attention to the matter of improving the efficiency of their shops by introducing new methods and modern equipment? It is true that previous to the summer of 1893, when the panic first struck the country, much had been done and more was projected in the way of improving shops; but unfortunately during the past two years the universal falling-off in railroad revenues due to hard times and the consequent severe retrenchments has forced the suspension of all improvements not absolutely necessary. Now that the worst appears to have passed and business is slowly resuming its normal proportions, we are justified in hoping that the necessity for such severe economies will soon be over, and that deferred plans as well as new ones can then be carried out.

That there is much room for improvement in the arrangement and equipment of very many railroad machine-shops in the country admits of no argument. Many of them are carrying on their work in buildings some of which were erected 30 to 40 years ago, and, though enlarged from time to time, have not kept pace with the increase in the amount of work to be done; and it is a rare thing to find a shop in which some portion of the work has not been crowded into the roundhouse. Many of the tools are as old as the shops, and should long ago have been consigned to the scrap-pile. There seems to be a curious sort of conservatism among master mechanics and shop-foremen that leads many of them to hold on to these old fashioned tools that have served them so well, when instead they should make every proper effort to have them replaced with improved modern tools. Not all the responsibility for this, however, belongs to those in charge of the shops. Master mechanics know too well the difficulty they often have in convincing those in authority that they cannot get along another year with the old tool, which, no matter how well it has been kept, has outlived its usefulness.

There are many railroad machine-shops in the United States to-day where a few thousand dollars wisely expended in the purchase of modern equipment would give as good returns to the road as any investment it could make.

In considering the plans for a new plant, or for extensive additions or alterations to one already existing, the aim should be to have the shop-buildings of ample size for the present needs, to provide for extensions and additions that may be needed in the future, and to place the buildings as compactly as possible, leaving between them only yard-room enough for such material as it may be necessary to store.

If the ground-room allowed is ample, the aim should be to leave such of it as is not occupied by the buildings mainly on the outside of the plant. This, of course, can be used for the various storage-tracks that will be required.

Nothing adds more to the expense of operating shops than the cost of carrying work over long distances and the time consumed by the workmen in passing from shop to shop.

The most bulky parts, such as boilers and tenders, can be kept on the storage-tracks and quickly brought in by a small locomotive when needed; the smaller parts do not require a great deal of room. Especially is this true of shops devoted principally to repairs.

At many shops much old material is kept that has been taken from locomotives which have been cut up; because it is thought that this can be further utilized, it is sometimes kept for years.

While there is a measure of economy in this, it would many times be better to sell the material at once for scrap and put the money into something that could be made of immediate use. Doubtless there is economy in the saving and working-over of old material, but often this is carried to excess, and good judgment is required to know when the limit is passed.

There is much that might be said regarding the design, construction, and material of the various shop-buildings, but these are matters that must be regulated largely by the amount of funds available for the whole work. In general, it may be said that it is poor economy to put up wooden structures for shop purposes. An examination of a large number of the best machine-shop plants will disclose the fact that, while for various reasons there may be differences in construction of buildings and their location with respect to each other, the general designs are conventional; the types may be said to be two in number.

The most common is that where the locomotives are placed in a row side by side on tracks leading from a transfer-table. For shops where the number of engines handled per month will not exceed two or three for heavy repairs and six to eight for light repairs, this is probably as good a plan as any, especially where the same transfer-table is utilized for a car-shop which may be opposite. Very few machine-shops so located are provided with facilities for taking down and putting up the work, and in many of them the old plan of "jacking up" is still followed.

Very great economy can be effected by equipping such shops with a drop-table for removing driving-wheels, and with light overhead cranes adapted for quickly handling the parts. Large shops, where many heavy repairs are to be made, and where perhaps new engines are built, undoubtedly should be supplied with modern electric cranes, and I am decidedly of the opinion that the best arrangement for such shops is the long-track plan, placing the engines one ahead of the other in two or more rows, with a center track kept open for bringing in and taking out engines and needed materials.

The old slow-moving rope-driven and "square shaft" cranes are very limited in usefulness, because of their slowness, and for this reason they have never been regarded with favor in railroad shops and locomotive works in the United States; but the introduction of electricity as a motive power has wrought a marvelous change here.

With the long-track plan two single-trolley cranes are required, but, as each handles but one-half the total weight to be lifted, they can be made much lighter than a heavy double-trolley crane capable of lifting the heaviest engine, and the cost of both cranes should not be much greater than that of the heavy one with its double trolleys. It is seldom necessary to work both cranes together; consequently there are two cranes usually available for the lighter work, and, if they are fitted with auxiliary hoists of 2 or 3 tons' capacity, it will be found that, as savers of time and labor in the operations of an erecting shop, they are invaluable.

With this arrangement, if the work is not extensive enough to require a separate building for boiler-work, a portion of this one can be devoted to it, the cranes being used not only for transferring boilers, but for all the heavier operations.

Although such a building is necessarily high, the overhead machinery needed can be carried on gantrys, which need not interfere seriously with the operations of the cranes.

The old plan of furnishing from one source the motive power for the entire plant and conducting it from shop to shop by shafting, belting, ropes, and other expensive devices is fast becoming obsolete. The demands of the service are so irregular and exacting that it is practically impossible to keep the work evenly divided, and almost daily some part of the machinery must be run overtime.

This has gradually led to the equipment of each shop with a separate engine, thus making it independent of the others.

Objections have been made to this plan because of its greater first cost and the increased expense for maintenance and attendance, but there is no doubt that it is generally the cheapest method if we take into account the amount of power expended in driving shafting, belting, and other machinery that is doing no work and might as well be idle. The adaptability of electricity for this purpose admits of no question at the present time.

Five years ago one might well have hesitated before introducing electric motors for driving lines of shafting or machinery. Anything that was done in this direction was necessarily experimental. To-day one may adopt this method of distributing power with every assurance of satisfactory results. There is no place to which it is better adapted than a railroad shop, and those who may have the planning and installing of the motive power either in a new shop or in one that is being improved will do well to carefully investigate the present status of the question. Electricity is particularly well adapted for lighting railroad shops. After several years' experience with a large plant wholly lighted by electricity, I am prepared to say: "Put no gas-pipes in a new shop," and to further recommend that all old ones be fitted with electric lights as soon as possible, and that *the* *gas be cut off entirely.* The large amount of gas-pipe that is required even in shops of moderate size, and the consequent leakage that is constantly going on, is no small item of expense. The light from gas is at best only indifferent, and every one of experience knows that in the short days of winter nothing like a full amount of work can be done during the hours when it is necessary to use gas. On the contrary, with a proper distribution of arc lights for general illumination, and each machine and bench supplied with an incandescent lamp, the work can be carried on as well by night as by day, to say nothing of the fact that the electric light is vastly more satisfactory and healthful to the workmen. The plant once installed, the expense, where care is exercised, is no greater than when gas is used, but rather less.

In selecting the tool equipment it is poor policy to take the cheapest that can be had. There is an old saying among workmen that "anybody can do a good job with good tools, but it takes a good man to do a good job with poor tools." While it is essential that locomotive work should be well fitted up and accurate within reasonable limits, the accuracy and close fitting necessary in the manufacture of machine-tools and the finer grades of general machinery are not here required, and the greater portion of railroad-shop workmen are not, as a rule, apt to be high-grade mechanics. What is needed is that the tools should be heavy and strong as well as convenient and well-built. With such tools properly handled, the cost of machine-trimming and finishing of forgings is considerably less than the smith-shop cost of the same work.

It costs a little more to have a planer fitted with two heads on the cross rail, and still more to have one or two heads on the uprights, but often this more than doubles the capacity of the machine and pays handsomely in the end.

Mr. H. L. Arnold, who has given the subject of the use of milling machines a great deal of attention, said, in a paper entitled "The Economic Possibilities of the Milling Machine," which appeared in the April number of the ENGINEERING MAGAZINE, that "the time is very near at hand when the milling machine, with its multiple-toothed cutter, will take the place in the general engineer's plant which it has already won in thousands of special instances."

Perhaps it is too much to ask that railroad mechanics, who have little time to devote to working up new methods, should take the lead in this matter, but they can at least take advantage of the knowledge that has already been gained, and, if they carefully seek for this and apply it with judgment, the result will certainly be more milling machines and less planers, shapers, and slotting machines and the change will be accompanied with economic results.

As an auxiliary to the smith shop, the cold saw is a valuable machine, and one or more should be included in the equipment of every railroad shop. The amount and character of the work that can be done on these machines would be a surprise to some who are not now acquainted with their useful features. An automatic saw-sharpening machine is absolutely essential to the economic success of the cold-sawing machine.

Excellent light boring mills are now made in sizes that will swing work up to 3 or 4 ft. in diameter and can handle to good advantage a large amount of locomotive work that is now done in large lathes. These mills are made very stiff and strong, and much attention has been paid to the details of speed and feeds. They are made with one or two heads on the cross rail, which may be either plain or turret, and the tables are provided with excellent chucks. The ease with which the work can be got on and off the machine well adapts it to such work as pistons, cylinder-heads, and dome covers, and by its use the cost of machining such parts can be reduced 15 to 30 per cent. and the output increased.

Among other tools not generally found in railroad shops, and the use of which tends to cheapen the cost of production, may be mentioned the turret lathe and the open side shaper of the Richards design. The latter can be used to good advantage for a large class of work that would otherwise require a planer costing twice as much. Most shops use the Fox lathe for finishing their brass fittings, but no large shop can afford to be without one or more turret lathes, for these, with a few special tools, will make a very great reduction in the cost of such work. Many other small parts can also be cheaply produced by these machines.

The tool-room should be a prominent factor in every well-conducted shop. It should contain a full equipment of standard machine-tools of the best makes, and be in charge of a progressive man of ability and judgment. The supply of small tools should be liberal and given out on the check system, which, if properly carried out, insures their being kept in good order and promptly returned.

The many uses to which compressed air can be applied are being thoroughly appreciated by railroad-shop people, and no plant is now complete without its compressor and system of piping. For light work the convenient hoists are invaluable. The cost of fitting out with air-hoists is comparatively small, and the saving in time and labor that can be effected will quickly repay the investment. For large shops a hydraulic plant is now almost a necessity, especially for the heavier operations of flanging and riveting boiler and tank work; and the time is not far distant when much forging work will be profitably done by hydraulic machines.

In the smith shop the aim should be to reduce the amount of hand forging by providing a suitable number of hammers and forging-machines, and also by cutting down the amount of finishing work through not forging so close to size and removing the surplus stock with heavy tools in the machine-shop.

Shafting should be run at higher rates of speed; two hundred revolutions per minute is not too fast for machine-shop work. It should be fitted with plain flange couplings and self-oiling bearings. All pulleys on the main lines should be split, and be as light as possible. The wrought-iron or steel-rim pulleys that are now made are well adapted for the work, are both cheap and light, and give excellent satisfaction.

High-speed shafting with pulleys of proper size on countershafts gives high belt speeds and greater horse power with narrow belts. In a plant so fitted, where there are over 12,000 ft. of belting, the widest driving belt is 12 in., and 60 per cent. of the machine belts are not over 4 in. in width.

The piece-work system is coming into more general use each year, and usually with beneficial results. When properly managed, there is nothing that will add more to the output and lessen its cost than this system, but it must be wisely handled to get the best results. Some one has said that the difference between piece-work and day-work is that with the latter the men must be watched, while with piece-work the work must be watched; this expresses the situation. With a proper system of inspection and a wise policy in fixing and maintaining prices, both the men and management will have perfect satisfaction.

The old railroad shops that used to build a few locomotives occasionally, "just to keep the men and tools busy," have found of late years that, considering the prices at which they can now buy, they are no longer justified in building, and principally for the reason that most of the locomotive works have practically rebuilt their plants and renewed their equipment, and have not hesitated to avail themselves of every modern device to cheapen the cost of production, while the shops have not progressed in a like measure. If, then, the former have found it profitable and even necessary to make these heavy expenditures in order to hold their trade, is it not reasonable to suppose that railroad shops could effect at least a measure of this economy in their legitimate work, if they followed more closely the example of those from whom they purchase their power?

A REVIEW OF RAILROAD INVENTION.

By C. P. MacKie.

ADOPTING the conventional allowance for such periods of time, the present year marks the completion of the second generation of railroad life in the United States. The snorting, rickety little "Stourbridge Lion" of 1829 has been replaced by such giant locomotives as those which commanded the world's admiration at the Columbian Exposition; the modest 15 miles or so of the Delaware and Hudson and the Baltimore and Ohio railroads of that year have expanded into the 8000-mile "systems" so familiar to travellers and Wall street operators; the tiny, cramped coaches of the same epoch have been supplanted by the running-hotels of Pullman and Wagner. There are on the 225,000 miles of railroads in this country 36,000 locomotives, 27,000 passenger-coaches, and 1,175,000 freight-cars, to say nothing of many thousands of four- and eight-wheeled odds and ends. These vehicles transported, in 1894, 757,000 tons of freight of all kinds, and 629,000 passengers. They, and the railroads operating them, were served by an army of nearly 900,000 employees. Such being the proportions of our railway traffic at present, as compared with its puny beginnings, it is not inopportune to inquire whether corresponding progress has been made in the essentials of speed, safety, and comfort; nor is it uninteresting to recall to mind the men (too many, unfortunately, already forgotten) who have contributed to make 24 hours passed in a 1000-mile railroad journey to-day less fatiguing and far safer than the same length of time spent in covering 100 miles 30 years ago.

Few instances of great industrial development present a more orderly sequence of progress from small things to great than does the mechanical history of our railways. There have been but very few sudden and general "revolutions"; it is rather a story of intelligent and, in the sum, successful working-out of competent means to meet evident needs. Unlike nearly every other modern industry, the railroad arts cannot be accused of borrowing anything from China or Egypt. There has been no lack of originality, and that of the highest type; but the growth of railroad equipment and apparatus is more a matter of quick and capable adaptation than of new principles and new elements. Like nature herself, the railroad inventor has not advanced by leaps and bounds, but by slow and patient evolution.

Neither speed, safety, nor comfort is possible in railroad work without a thoroughly good track, and it is only within the last 25 years that any general effort has been made to secure excellence in this respect. The fundamental elements are older than the use of steam; iron rails (of "snake-head" memory) were in use nearly half a century before the first locomotive jolted over them; flanged iron wheels are but little less aged; sleepers were used in the wooden tramways of the seventeenth century; ballast was contemporaneous with furnace-cinders and gravel-pits; bridges, for purely railroad purposes, were easy to build, after Cæsar's plan, in a country where wood was more plentiful than stone. The strap-rail soon proved its inadequacy, but the invention of the fish-plate in 1844 by Robert Barr was the first step in the direction of a substantial track. The "T" rail, when first brought out by its inventor, R. L. Stevens, in 1830, had a hard fight to win its way against its "double-headed," "bridge," "U," "Barlow," and "bull-head" predecessors and successors; but it did win, and first made heavy engines and fast speed economically possible. Blake, with his rock-crusher, provided the means of securing cheap and abundant stone ballast, and Howe and Fink, with their bridge trusses, had already paved the way for the huge iron and steel viaducts of later days. The locomotive- and car-builders had also made such advances in augmenting the size, weight, and speed of their products that they were, in effect, waiting for better and safer tracks in order to obtain the improved results which their achievements made possible, but it cannot be said that these two branches of railroad development attained anything like equal excellence until after the civil war. In the late sixties and early seventies, however, the maintenance-of-way departments in progressive and carefully-operated roads could truthfully say to the motive-power men: "Come on! we can handle anything you dare put on wheels."

Leaving out of the question, as apart from our immediate subject, the immense advantages secured to railroads by the introduction of steel rails and the greatly increased sections, which were so largely due to the labors of Ashbel Welsh and O. Chanute, the chief factor in the rapid improvement of railroad service which has marked the last quarter century was, necessarily, the locomotive. Fast time, *per se*, was no novelty to either engine-makers or their drivers. Baldwin's first engine, the "Old Ironsides," made, it is said, a record of 62 miles per hour in 1833, only 4 years after the "Stourbridge Lion's" début. Other equally fast, or faster, spurts were common enough in succeeding years; but fast time, as a regular, every-day, matter-of-course incident of the general service, was not practicable with the engines and tracks of earlier years. It would be trespassing too far on the reader's patience to attempt to sketch, even lightly, the myriad steps which have marked the evolution of the leviathans now harnessed to our express trains. Probably the two contrivances which contributed most immediately to the rapid and enormous development of the American engine were the pivoted truck, first introduced by J. B. Jervis on the Delaware and Hudson railroad in 1831, and the equalizing lever invented by Joseph Harrison of Philadelphia in 1838; for these two improvements gave to our locomotives their most notable characteristics,—flexibility and adjustment to the peculiar conditions of their operation. As far back as 1836 Campbell of Philadelphia built the first eight-wheeler; in 1847 the Norrises of the same city made a ten-wheeler for the Reading railroad; in 1863 Rogers of Paterson turned out the first "Mogul"; in 1866 Mitchell built the first Consolidation; the following year Norris of Lancaster completed the first decapod. And so the record could be prolonged almost indefinitely, until it should become a list of nearly all the master mechanics, motive-power superintendents, and clever shop-men of half the railroads and machine-shops of the country, down to the last few years when we reach the triumphs of the Altoona or Mt. Clare Shops, and of the Baldwin, Schenectady, Brooks, and Rogers Works. None of these giants are the product of one brain or of any combination of brains in the service of one employer; from head-light to buffer, and from truck to smoke stack, they are the outcome of manifold minds, incalculable experience, and highest skill. The best ideas of England, France, Belgium, and Germany have also been adopted, transformed, and utilized, whenever and wherever advantage could be obtained, and the crowning success of one decade has been sent to the scrap-heap in the next by the relentless pressure of competition and progress. In no department of mechanical construction is the pressure more insistent, and in none is the old saw as to one man's meat being another man's poison more aggravatingly applicable. Each road must study its own peculiarities, and each branch of every road's service must have its special requirements met by special means. Hence the apparently infinite variety of locomotive types met in a day's run over busy lines, and the bewildering chaos of detailed invention out of which the stately "Express" and the impudent little "Tanker" alike emerge. The products of 1894 and 1895 are the invention of no man, native or foreign; they are the syntheses of the labors of two generations of practical mechanics, each adding his quota of discovery or adaptation to the mass, and each, whether nameless or famous, entitled to his share of credit for the degree of perfection thus far attained in that Proteus of machines,—the American locomotive.

Given a fast and relatively economical locomotive, it was sure to be laden to its fullest capacity and driven to its utmost limit of practicable speed. Many of our readers will no doubt recall the stuffy, rickety little boxes in which we used to stew in summer and roast (or freeze, as the weather and the brakeman might determine) in winter, while we fondly imagined we were travelling "first-class." How the wood-cinders did pour through the little 10×12 windows! How the atmosphere grew gamier and gamier, and the aisles dirtier and dirtier, and the seats harder and harder, as we were bounced and jolted and yanked along through an endless cloud of sand and live-coals by day, and live-coals and sand by night! We know a man, now a white-haired, distinguished citizen of this republic, who to this day never catches a whiff from a freshly-roasted peanut without thinking of the old Camden and Amboy railroad. It is not surprising that thoughtful men should early have turned their attention to the preservation of over-strained rolling-stock and the alleviation of human suffering by reducing the wear-and-tear of journeys such as those were. In truth, many of the railroad lines were becoming so long that neither the vehicles or their contents could be counted on to stand the strain for an indefinite time. The passenger profited by both efforts. The first step was to provide something more comfortable for night travel than the abominable car-seats then in use, and in 1836 the Cumberland Valley railroad introduced the use of rude sleeping-cars on its night trains. These were an immense improvement upon the former cramped accommodations. But, at best, their berths were a very poor substitute for a bed. In 1859 Mr. Pullman brought out the first cars furnished with berths and lavatories, wherein could be more or less dimly discerned the progenitor of future Pullmans and Wagners, and in 1864 they were followed by the first true sleeping-cars. The proposal to run such sleepers on all night-trains met a certain amount of opposition from ultra-conservative railroad managers, but the more enterprising and far-seeing took up the idea with energy, and by 1870 most of the railroads of the country had a regular sleeping-car service established. The "parlor car," with its greater independence and increased comfort, was not so generally demanded by the travelling public as was the sleeper; it was more of a luxury. But upon its appearance it quickly became popular, and was followed in 1869, on the Chicago and Alton railroad, by its natural development,—the dining-car. Once a railroad had sleeping-, dining- and parlor-cars running on its trains, with their exclusiveness and higher rates of fare, it was an easy step to hitch a number of them together, without any ordinary coaches at all, and so construct a strictly "limited" train. This was first done in 1872 on the Pennsylvania railroad, and, while not involving "invention" in the patent-office sense of the word, it certainly has contributed vastly to both the comfort and the rapidity with which long trips are made.

The name of Mr. George M. Pullman is so universally associated with all the various classes of this special service that he is generally assumed to be the originator of these several kinds of luxurious cars. Unquestionably Mr. Pullman has shown a greater capacity than any one else for developing the manifold detail of the service, whether in the direction of construction or operation, and in administrative abilities he is distinctly the leader of all who have labored in this field. At the same time the travelling public at large are too much indebted to Wagner and Mann to warrant a neglect of their names in dealing with the evolution of the drawing-room- and sleeping-car. Each of these three designers had novel ideas, peculiar to himself, regarding the ways by which the public comfort could be increased, and experienced travellers find in the cars of each some feature or detail which is lacking in the others. None of them are perfect, but a sleeping-car which should embody the best features of all the systems, and be decorated in the purest style of the best designers taken from the several companies, would come very near to being perfection. Of the several inventions entering particularly into the building of these cars perhaps the two most important are the method of lowering and raising the upper berths and the vestibule-connections. The priority of invention in both these appliances has been disputed, but it is only recording facts, and not expressing an opinion, to note that the suspended upper berth was first used in 1864 by Pullman, and the vestibule in 1886 by the same inventor, although as far back as 1857 a covered way between cars was in use on the Naugatuck railroad in Connecticut.

Scarcely less essential to the passengers' comfort than the sleeping-car and its companions were certain improvements introduced, at approximately the same period, in the construction of passenger-cars of all kinds. Of these the safety-coupler, the use of hot-water and steam-heating apparatus, and the employment of gas for illumination were the principal. The first radical improvement in coupling coaches so as to hold a train solidly together was, in general application, the Miller platform and coupler, which came into somewhat general use in the later sixties, and at once robbed passenger-trains of their last remaining resemblance to a string of coal-hoppers. Of course there have been many other admirable coupling devices, possibly earlier and more meritorious, but it was the "Miller" which inaugurated in a large way the reform in the abolition of the leap-frog style of running trains. In the same way Wm. Martin of Dunkirk is believed to have originated the method, now so general, of heating the train with steam drawn directly from the engine, although there has been the usual patent-wrangle over this idea. W. C. Baker in 1867 brought out his excellent plan of hot-water circulation in connection with his safety-heater, and did as much as anyone else to establish an equable and wholesome temperature in passenger-coaches. To a German inventor, Mr. Pintsch, we are indebted for the first practical application of illuminating gas to car-lighting, although other good systems have been produced since the introduction of the Pintsch light in 1877. Finally, the gradual improvement in trucks, the invention of the paper wheel by Allen and the borrowing of the large spoked wheels of our English friends, the nice determination of spring resistances, the production of car-seats fitted to the lines of the human body rather than to those of a wooden mannikin, and other similar minor improvements, all contributed sensibly to the attainment of that degree of comfort which has become so habitual to us that we rarely give a thought to the manifold steps by which it was secured.

With increased speed, heavier trains, and more costly equipment arose the obligation—imposed by considerations chiefly of self-interest—to provide reasonably adequate protection for the property and humanity handled by the road. For a long succession of years the safety-appliances of the most advanced railroads consisted of what Whistler would call "an arrangement" in flags and lanterns, with an understudy of bells, cow-catchers, and whistles to supplement it. The manually-operated semaphore was borrowed from the French, *via* England. It originally was, as its name implies, a visual telegraph, and, among other notable feats, signaled throughout France the arrival of Napoleon at Frejus, when that luckless hero started in the campaign which ended at St. Helena. The idea of using this old-time "telegraph" as a railroad signal is credited to Sir Charles Gregory, and, when it was put to this use on the Croydon railroad in England in 1841, it achieved quick success, and was promptly introduced into American practice. Prior to that there were numberless signals (as, in fact, there have been ever since) consisting of balls, disks, odd-shaped pieces of metal or board, etc., intended to inform the engineer of a train as to the condition of main track or sidings, or to control him at stations, crossings, etc. But the first really practical and efficient method of signaling was secured when the "block system" of protection was imported from England. This, with the mechanical improvements made by Saxby & Farmer and the electrical ones added by Sykes, was the origin of most of the really successful signal work done on our railroads. The exceptions are the ingenious and elaborately-perfected system of electro-pneumatic signal control invented by Mr. George Westinghouse and his associates, and the well-planned "disk" or "banjo" signal system invented by the elder Hall. Both of these systems are automatic,—*i. e.*, the approach of the train itself sets, and its passage releases, them. Both have their advocates, and both have met with much merited success. Besides these very prominent types of signals, there have been produced a host of others, many of them possessing notable merit, but all patterned more or less after English originals. A distinctly novel departure was introduced by Professor Koyl a few years ago, in his "illuminated parabolic blade," whereby a bar of light was projected at night in positions and colors corresponding to those of the semaphore by day. For the present, however, this admirably-conceived invention has, we believe, been withdrawn for further elaboration by its designer.

In securing fast train service, not less important than proper signal protection is the secure and rapid control of switches and other track-interruptions; but, while several highly successful methods are in general use to accomplish this end, they do not, except in detail, differ widely from the best foreign practice. An exception should be made for the original and thoroughly-designed system of switches invented by Mr. Joseph Wharton of Philadelphia, and introduced by him in the early seventies. By this method the main line of rails is left unbroken, and the means of deviating a train is brought under the wheels only when positively required. The advantage of such a plan will be apparent even to the layman who recalls the slight jar felt when passing over switches, however well laid, of the older styles.

We have purposely left to the last what, in the opinion of every unbiased railroad man in our own and foreign countries, is the crowning individual triumph of American railroad invention, and its most distinctively native production,—the Westinghouse air-brake. Dating in its first form from 1868, this apparatus fairly leaped into prominence in the next few years, and, spreading from the locomotive back to the entire passenger-train, soon invaded the freight service, and is now as common on freight-cars as it was on passenger-coaches not many years ago. In the production of this appliance both inventive and technical skill of the highest order was required, and the result was incomparably the greatest contribution to railroad management that has been offered since the first locomotive-wheel was turned by steam. Those who are happily too young to remember the ante-Westinghouse days on our own lines need only recall the behavior of passenger-trains on such foreign roads as may not use the air-brake in order to realize what our present "limited" trains would be, were it not for this invention.

In reviewing the additions made by the second generation of railroad inventors multitudinous inventions of greater or less importance will recur to every practical mind, of which no mention has been possible. All alike are the outcome of study, thought, experience, and adaptation on the part of men of inventive talent, whose labors we profit by and whose personalities we ignore. Yet they have all played a part, and an important one, in making railroad-travel the pleasure it is to-day, instead of the penance it was 30 years ago.

The lines on which our inventors have to do their future work would seem to be far more clearly defined than ever before. There is no engineering reason why speed of 100 miles an hour should not be maintained on fast trains; the objections are commercial rather than technical. The chief obstacle lies in the ponderous and wasteful mechanisms needed to generate the requisite amount of steam under even the best present methods. The remedy will be found when electrical energy can be generated in a simpler and less expensive manner than hitherto, and signs are not wanting that the inventor is at hand. In passenger-trains not only are too many horse-powers needed to carry each ticket-holder to his destination, but he demands that too many hundred weight of dead material be dragged along with him. Within the walls of his temporary home he is entitled to better ventilation and far better light than he is apt to get, and electricity will provide him with both, as soon as inventors cut loose from old lines of effort. Some benefit has been derived, and much more may reasonably be expected, from the experiments made in introducing steel frames into cars, and otherwise increasing their structural resistance to abnormal shock or accident. Outside of the train, the great desideratum in signal operation—the raising or lowering of the semaphore by directly-applied electrical force—is certain to be attained, if we may judge by the considerable advance already made. In truth, it will not be many years before a train can, and no doubt will, run through its successive blocks by the glare of electric lights, leaving each block in darkness as it enters and lights the next. It is not safe to assume that the railroad inventors of the United States have become extinct, or their art a lost one. What has already been done is but an earnest of what the future holds in reserve. The very fact that the representatives of the great lines now meet constantly, comparing ideas, adopting suggestions, and determining, with all the advantage of aggregated skill and experience, upon the best average types as general standards, is significant in the highest degree. And, after all, in that very coöperation we have an invention which has no peer in railroad history. Who was the inventor of the modern associations it is past the art of investigation to fix with justice, although the name of Albert Fink must ever occur to railroad men in this connection; but none will deny that all interested in railroads, whether passengers or presidents, owe an ever-increasing debt to the minds that first displaced the jarring jealousies of the rival roads by the methods of concord and fraternity.

THE CAUSES OF RAILROAD ACCIDENTS.

By Julien A. Hall.

RAILROAD accidents in this country cost too many lives and too much money. That the cost can be reduced is a matter beyond doubt. The railroads have it in their hands to protect the lives of their passengers and employees, and they should do it.

Many, perhaps, will ask how this can be done. At first sight the magnificent piece of machinery called the locomotive seems as perfect as science and art can make it; the splendid cars, with every convenience for comfort in riding, eating, and sleeping, seem all that could be wished; but "The World Almanac" says that for the year ending June 30, 1893, the total number of people killed and injured in railroad accidents in the United States was 7346 and 40,393 respectively. Is not this startling, and does it not show that there are weaknesses in our system of railroading that should be cured? But this cure cannot be effected as long as the paying of a dividend at a certain time is looked upon as a matter of first importance.

During the last 20 years the improvements in railroads have been remarkable, but they must be more remarkable in the next 20. When we see crashing past us that enormous mass of iron and wood called the Vestibule Train, we are prone to wonder at the wide difference between the construction of this train and that of a bicycle. A 21½-lb. "safety" will carry a 150-lb. man at nearly the same rate of speed as the train, but for every 150-lb. man the Vestibule Train must carry a dead weight of between 3000 and 4000 lbs. Now, as the bicycle is a practical machine, the train must be unnecessarily heavy; and, if there is such a discrepancy in one important point, may not an equal discrepancy exist in other important points?

I am well aware that the man who undertakes to suggest changes and improvements tending to prevent railroad accidents places himself in a position where he can be sharply criticised by practical railroad men. An unwilling listener can always find in existing conditions a multitude of reasons for maintaining that such suggestions are theoretical or impracticable, because they cannot now be carried out. The world is naturally conservative, and the majority can always be found in opposition to innovation and improvement; but the conservative policy is not always the safest and most profitable in railroad management, and, as a practical man, I maintain that it can serve only a good purpose to review the conditions which make possible the costly and disastrous accidents on American railroads.

To begin with, our roadbed is unstable. Our embankments, instead of being so narrow on top, should be made broader and with longer slopes, and more masonry should be used in connection with their general construction, especially where there is a probability of high water. It is not unusual for a train to be delayed for many hours by a washout, which would never have occurred had the embankment been properly built and protected ; such delays are troublesome, expensive, and unnecessary,—avoidable by the use of brains and money.

Excavations should be made very wide and the side-slopes very flat, thereby reducing the probability of slides. All rocks, trees, and stumps close to the edge of the excavation should be removed, in order to prevent them from falling on and obstructing the track. Crossings of tracks should be either above or below grade. Where there are adjacent tracks, the space between them should be sufficient to allow people to stand safely between trains, whether moving or stationary.

Side-tracks should never be located on a grade, making it possible for cars to be blown or pushed off, or run off by gravity. Horrible accidents have been caused by wild cars on the main line.

The track should be completely fenced on each side, from beginning to end, and carefully policed in order to keep off strangers and cattle. Cattle-guards should be of metal and of the most approved pattern, and should be maintained as well as the track.

The time for cheap railroads has passed. When we first began to build railroads in this country, we had to take what we could get ; but now it is different. Now we pay our money for safety, comfort, and speed, and we should refuse to have, instead, the possibility of being crushed, burned, or otherwise tortured.

In our bridges we are satisfied with a safety-factor of six or seven ; in Europe such structures are three to five times as strong as ours. Our bridges are easily washed away, crushed into scrap iron, or burnt up. Our masonry gets undermined by water, and, unless the danger be discovered in time, perhaps a dozen passengers are drowned. The masonry-supports for our bridges should be placed on firm clay, solid rock, or founded in other suitable manner.

We should avoid wooden trestles and bridges. There is great danger from fire in these structures, and the replacing of them by metal and stone would do away with it. A burning coal dropped on a dry timber will often set it on fire, and will sometimes burn through it, or so weaken it that, unless the damage be discovered in season, an accident will result. We should construct only iron or steel bridges and viaducts, with a large factor of safety ; and, when possible, heavy masonry arches should take the place of these structures. They should be regularly inspected by competent men, and not from the rear end of a train.

It is no more reasonable that a navigable waterway should be crossed in a manner to obstruct vessels than that a street or road crossing should be crossed at grade; but drawbridges should not be used, except where it is absolutely impossible to avoid them. Many accidents happen annually on account of drawbridges being improperly open. Fortunately for all concerned, the government takes a hand in the construction of new bridges over streams, and provides that a proper waterway shall be allowed; the demands as to clearance are not excessive. However, another point comes in here,—namely, that vessels should be, as far as possible, so constructed that they will require less head room or that their greatest projections can be folded down. No doubt this will be done when steamboats entirely replace sailing-vessels.

Our railroad track is full of defects. The use of wooden ties is unsafe,—not to mention the wholesale destruction of the forests caused in order to obtain these temporary supports. The rails cannot be securely fastened to them, and the result is that they are easily torn up, spread, or broken. The ties are easily displaced, especially on bridges and trestles, and such structures are so lightly and unsafely built that, when an accident occurs on them, there is but little chance to save trains from destruction.

The spikes supposed to hold the rails to the ties are totally unfit for the purpose. The constant springing, straining, and pounding produced by the wheels work the spikes loose, and I have seen the heads of spike after spike sticking up half an inch above the rail, instead of in contact with it, thus rendering the turning-over of the rail a very easy matter. This state of affairs can be improved. A system of metal track should be devised by which rails would be held rigidly in place, and ties, if used, not easily displaced. By the use of a metal track, the rails can be bolted down and much more effectively secured than by the present system of spikes in wood.

Our rail is too light; often the heaviest is scarcely able to perform the work required of it. It is often made of inferior metal, and carelessly inspected; rail-inspectors should always be able to detect this trouble, but they do not always do it. I have seen all sorts of breaks in rail that had been inspected by a reputable inspector, some of which caused serious accidents. Our rail should be heavier,—not less than 100 lbs. to the yard,—and a system of fastenings should be introduced that would make the joint as strong as any other part. Now we have a weak place at the end of every rail length, and every rail-end is laminated, whether supported or suspended. If several rails were welded together, thus giving much greater lengths than our thirty-feet rails afford, and the joints provided with angle-bars that allow for expansion and make them as strong as any other part of the rail, we would have a track that would be much safer, more durable, and much less expensive to maintain. The base of our rail should be broader than the height,—say, twice as broad; as such a rail would be more difficult to turn over, greater safety would be secured.

Our present type of locomotive, from its reciprocating action, pounds our track to pieces and limits our speed. There is no good reason why we should not have in its place an electric motor that will not shriek and pop off steam until we are nearly deafened; that will not belch forth cinders and dirt and almost blind us, thereby making railroad travel a worry and vexation of the spirit. We do many things daily because someone else did the same before us.

The defectiveness of our way is one of the chief causes of accident, and, until the weaknesses mentioned, and others, are cured, the number of railroad accidents will continue undiminished. Safety in the operation of a railroad is largely a matter of mechanics, and we should systematize and strengthen our works on common-sense principles; when we do this, many lives and much money will be saved.

Another serious trouble is that our rail is not continuous, being broken in a number of places by switches and frogs. Perhaps only a higher wisdom than ours can tell us how to avoid accidents caused by open switches, as long as these dangerous devices are not eliminated from the track. This should be done, even if the cost of otherwise setting off the cars be more expensive. Let us make our rails absolutely continuous, and transfer cars bodily to adjacent tracks by the use of hoisting machinery. Such devices are used in England,—of course under the control of a block system,—and are found very safe and satisfactory. Particularly should tracks on which very fast trains are run be made continuous, as accidents to such trains are much more serious than those that happen to slow trains.

The track should be straight; where curves cannot be eliminated, they should be made very light. Reduction of curvature is simply a matter of money.

The matter of the elevation of the outer rail in track, on account of centrifugal force, should be studied, and the speeds of all trains over the same track should be made nearly uniform, in order that a rule for this elevation should be of some force, and not a dead letter, as it now is. Attention to this point would prevent many trains from running off the track on the outside of the curve; this generally happens when the speed is what we now consider very high, and therefore the results are more disastrous.

Our gage should be wider. We cannot reasonably expect our high, top-heavy cars to remain on the rails, when they are so close together. Such a widening of the gage would permit the use of cars of lighter construction, thereby decreasing cost of operation, maintenance, and liability to accident. The dead weight of from 1 to 2 tons per passenger is very excessive.

Cars cannot be much reduced in height, but they can be considerably widened, thereby reducing their liability to overturn. In order to further reduce this liability, the wheels might with a broader gage be placed on the outside of the cars and the body brought closer to the track. This would be much safer than our present high and narrow cars, held on the rails largely by gravity. The present system of constructing cars is bad, as is shown by the fact that, in case of collision, the cars are generally telescoped or crushed. Non-brittle and non-inflammable materials, such as steel, india-rubber, etc., should be used as far as possible in the construction of cars, as such materials give greater strength, durability, lightness, safety, and capacity for high speed.

Our systems of heating and lighting are very dangerous; in case of accident, the cars often take fire, and passengers are roasted. Electricity ought to help us out of this trouble. Generally our sleepers and dining-cars are equipped with many safety appliances that our day-coaches and smoking cars lack, but those who ride in the last-named cars have lives as well as their more fortunate neighbors in the sleepers, and there is no good reason why they should not enjoy the same safety, if not the same comfort.

This brings to mind another very defective construction to which we trust our lives whenever we travel by rail,—namely, the flanges of the car-wheels, the overhanging shoulder or lip, slightly over an inch square in section, that holds the trains on the track, and is all that stands between us and death or injury when we are travelling in these conveyances. We often hear of a broken wheel causing accidents on railroads, but, considering the demands by railroads for a cheap wheel, and the consequent deterioration of the metal of which the wheel is manufactured, it is surprising that there are not more accidents from this source. A form of wheel and rail should be devised by which almost absolute safety would be provided. The present form of wheel is an astonishing construction, and it is a cause for constant wonder that the violent jerks and thumps to which it is subjected do not break it oftener.

There are one or two plans of rail-guards in use for the purpose of holding a train on a trestle or bridge, in case of derailment, but they are inadequate. On trestles a wooden guard-rail is generally placed, but it is often defective from rottenness or other causes, and is practically worthless. On bridges a guard-rail is used, which might be valuable if the train did not collapse the trusses of the bridge, nine times out of ten, in lateral displacement on such structures. A strong guard-rail should be devised and securely placed where it will do the most good ; and it should be as carefully and as constantly inspected as the other parts of the bridge.

Air-brakes should be used on all freight trains. It is simply barbarous to force human beings to remain on top of freight cars in all sorts of weather and at night, risking life and limb in running over the cars to put on the brakes. Many men annually lose their lives from this cause, are seriously injured, or are ruined in health. The present system of brakes is often insufficient and defective. Hand-brakes are generally not sufficiently strong to slacken the train properly, and air-brakes, improperly applied, will sometimes cause the wheels to cease to revolve and therefore slide, the result being that the wheel flattens by friction with the rail. The wheel then not only makes a very disagreeable clatter, but is rendered dangerous to the rail, its constant impact in cold weather having been known to break a brittle rail and cause a serious wreck.

On many railroads there are old bridges that have not sufficient head-room to pass a train with a brakeman standing on top of it. As long as a brakeman keeps his wits about him and remembers that there is such a defect, he is safe ; but let him forget only once, and he is knocked on the head and as surely killed as he would be by a dose of poison. A clear height of not less than 8 ft. should exist between the top of the highest car and the inside top of the lowest bridge.

Another great source of accident is car-coupling. It is not enough for a railroad company to have a car-coupler or brakeman, when he enters its service, sign an agreement that he will not hold it responsible for any accident that happens to him in the performance of his duty ; nor is it enough for the company to make a rule that no man shall couple cars with his hand or go between cars while coupling. Men will be careless, whether car-couplers or not, and the railroad company should provide for this trait in human nature by equipping all of its cars with automatic couplers, which are usually safe. There are a great many freight cars in the United States, and to equip them all with some such device would require time ; but the railroad companies should be willing to take the time and spend the money in order to protect the lives and limbs of their employees.

The arrangements for guarding the lives of passengers and others. on station-platforms and at car-windows, are very incomplete, except at our largest cities. When a train comes rushing into a crowded way-station, there is very often nothing to keep the people out of its way ; many are inattentive and stand too close to the track, and others do not know how close they can stand with safety. Both classes can be and should be protected. Obstructions, either stationary or moving, should be kept at such a distance from the track that persons leaning from car-windows cannot be struck by them.

All passenger cars should be vestibuled, in order to prevent people from falling from the train when passing from one car to another while the train is in motion. The present vestibules seem very effective, but their mode of construction should be studied with a view to improving them.

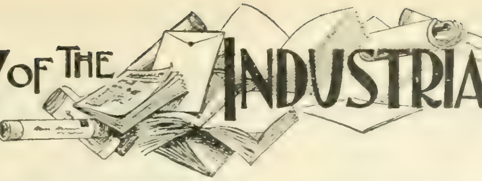
Inefficient and careless employees are often the cause of accident. Men are not apt to take vigorous measures for safety, unless they know that danger actually exists. And, when they have neglected some precaution several times and no bad results follow, it is very apt to be regularly neglected, except when there is actual danger known to be at hand. Trainmen have standing orders to approach stations with trains under full control. Some trains have a limited and specified time in which to make a run. Trainmen claim that, in such cases, they could not carry out this and similar orders, and get over the road as expected. In short, they consider such orders impracticable, and they trust to luck.

When working under such impressions, the sense of danger becomes less acute; experience, instead of acting as a teacher to make men more alert, produces generally the opposite effect of leading them to take chances that absolute safety does not allow. Trainmen are not the only employees liable to become careless; there is hardly an employee connected with the work of maintenance of way or operation who does not have some responsibility resting on him, but, in track work, bridge-work, and, most of all, the running of trains, the necessity is great for constant care and watchfulness on the part of every man.

The whole field of railroading is beset with dangers, and, until reforms on the lines indicated are put in force, it will be a hard matter to do the work without injury to the travelling public and employees. On those railroads that show the best record in this respect will be found the most thorough methods of maintenance of way and equipment, and the most consistent systems of operation.

No element of danger is as great as inefficient service, and the best service can only be obtained by employing men who take personal interest and pride in their work. This can be encouraged by making promotions carefully, having in view the filling of places with the men best fitted to do the work.

The American public is quick to appreciate efforts to improve. A general and continued improvement in railroad transportation is demanded by the people. Will the railroads meet the demand?



REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

INTRODUCTORY.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance ; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

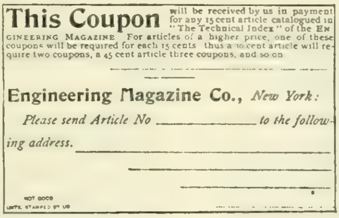
We hold ourselves ready to supply—usually by return mail—the full text of every article reviewed or indexed, and our charge in each case is regulated closely by the cost of a single copy of the journal from which the article is taken.

☞ The price of a single article is ordinarily 15c. ; those indicated by an asterisk (*) 30c. ; by a dagger (†) 45c. ; and above this, the price is given just after the number. In ordering from us care should be taken to *give the number* of the article desired, not the title alone.

The entire Review is conveniently classified into the recognized divisions of applied science—everything pertaining to "Architecture and Building" appearing under that heading, while "Civil Engineering" is given under that title, and so on alphabetically throughout. The titles and addresses of all the journals reviewed are given below, and in the body of the Index the titles are abbreviated—foreign journals in italics. Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell coupons—represented here in miniature.

The price of these coupons is 15c. each, or fifteen for $2, forty for $5, and one hundred for $12.



This Coupon will be received by us in payment for any 15 cent article catalogued in "The Technical Index" of the ENGINEERING MAGAZINE For articles of a higher price, one of these coupons will be required for each 15 cents thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on

Engineering Magazine Co., *New York:*

Please send Article No ______________ *to the following address.* ______________

NOT GOOD UNTIL STAMPED BY US

Simply fill in the number, and your address. A stamped envelope does the rest. No letter-writing is required.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their great convenience and economy.

THE PUBLICATIONS REGULARLY REVIEWED.

Arena. *m.*. $5. Boston.
American Architect. *w.* $6. Boston.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
American Analyst. *f.* $1. New York.
Architecture and Building. *w.* $6. N. Y.
Arch. Build. and Dec. *m.* $2. Minneapolis.
Am. Chem. Journal. *b-m.* $4. Baltimore.
Asso. of Eng. of Cornell Univ. 1894. Ithaca.
Am. Eng. and Railroad Journal. *m.* $3. N.Y.
Am. Geologist. *m.* $3.50. Minneapolis.
Am. Gas Light Journal. *w.* $3. New York.
Am. Jour. of Science. *m.* $6. New Haven.
Architect, The. *w.* 26*s.* London.
American Machinist. *w.* $3. New York.
Amer. Mag. of Civics. *m.* $3. New York.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. N. Y.
Am. Man. and Iron World. $4. Pittsburg.
Aust. Mining Standard. *w.* 30*s.* Sydney.
Architectural Record. *q.* $1. New York.
Archæologist, The. *m.* $1. Columbus, O.
Architectural Review. *8-q.* $5. Boston.
Age of Steel. *w.* $3. St. Louis.
Amer. Soc. of Irri. Eng. *qr.* $4. Denver.
Am. Soc. of Mec. Eng. *m.* New York.
Builder, The. *w.* 26*s.* London.
British Architect, The. *w.* 23*s.* 8*d.* London.
Brick Builder. *m.* $2.50. Boston.
Bul. Am. Geog. Soc. *q.* $5. N. Y.
Bul. Am. Iron and St. Asso. *w.* $4. Phila.
Boston Jour. of Commerce. *w.* $3. Boston.
Banker's Mag. *m.* $5. N. Y.
Banker's Mag. *m.* 18*s.* London.
Bankers Mag. of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Bul. of the Univ. of Wisconsin.
Calif. Architect. *m.* $3. San Francisco
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Colliery Engineer. *m.* $2. Scranton, Pa.
Canadian Engineer. *m.* $1. Montreal.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Chautauquan. *m.* $2. Meadville, Pa.
Century Magazine. *m.* $4. New York.
Canadian Mining Rev. *m.* $1.50. Ottawa
Commerce. *w.* 36*s.* London.
Cosmopolitan. *m.* $1.50. New York.
Contemporary Review. *m.* $4.50. London.
Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester
Domestic Engineering. *m.* $2. Chicago
Engineering. *w.* 36*s.* London.

Electrical Age. *w.* $3. New York.
Engineer & Contractor. *w.* $1. San Francisco.
Eng. Asso of the South. *m.* $3. Nashville.
Electrical Engineering. *m.* $1. Chicago.
Electrical Engineer. *w.* 19*s*. 6*d*. London.
Electrical Engineer. *w.* $3. New York.
Electrical Industries. *m.* $1. Chicago.
Electricity. *w.* 7*s*. 6*d*. London.
Electrician. *w.* 24*s*. London.
Engineering Mechanics. *m.* $2. Phila.
Engineering Magazine. *m.* $3. New York.
Eng. and Mining Journal. *w.* $5. N. Y.
Engineering News. *w.* $5. New York.
Engineer. *s-m.* $2.50. New York.
Engineer. *w.* 36*s*. London.
Electricity. *w.* $2.50. New York.
Electrical Plant. *m.* 6*s*. London.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s*. London.
Electrical Review. *w.* 21*s*. 8*d*. London.
Electrical Review. *w.* $3. New York.
Eng. So. of W. Pa. Proc *m.* $7. Pittsburg.
Electrical World. *w.* $3. New York.
Forum. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Fortnightly Review. *m.* $4.50. London.
Fire and Water. *w.* $3. New York.
Fairplay. *w.* 32*s*. 6*d*. London.
Gas Engrs' Mag. *m.* 6*s*. 6*d*. Birmingham.
Garden and Forest. *w.* $4 New York.
Geol. Mag., The. *m.* 18s. London.
Gas World. *w.* 13*s*. London.
Heating and Ventilation. *m.* $1. N. Y.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Indian Engineering. *w.* 18 Rs. Calcutta.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Iron & Steel Trades' Jour. *w.* 25*s*. London.
Ill. Carpenter and Builder. *w.* 8*s*. 8*d*. London.
Iron and Coal Trades. *w.* 30*s*. 4*d*. London.
Iron Ind. Gazette. *m.* $1.50. Buffalo.
Invention. *w.* 11*s*. London.
Iron Age. *w.* $4.50. New York.
India Rubber World. *m.* $3. New York.
Industry. *m.* $2. San Francisco.
Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Chem. So. *m.* $5. Easton.
Jour. Assoc. Eng. Soc. *m.* $3. St. Louis.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Jour. Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. As. *q.* $2. New London.
Jour. Polit. Economy. *q.* $3. Chicago.
Journal of the So. of Arts. *w.* London.
Locomotive Engineering. *m.* $2. N. Y.
Light, Heat and Power. *m.* $3. Phila.
Machinery. *m.* 9*s*. London.
Machinery. *m.* 50 cts. N. Y.
Manufacturer and Builder. *m.* $1.50. N. Y.
Marine Engineer. *m.* 7*s*. 6*d*. London.
Metal Worker. *w.* $2. N. Y.
Milling. *m.* $2. Chicago.
Mining Review, The. *w.* $2. Denver.
Mining Industry. *w.* $3. Denver.
Mining World, The. *w.* 21*s*. London.
Mining Jour, The. *w.* £1. 8*s*. London.
Monist, The. *qr.* $2. Chicago.
Manufacturer's Record. *w.* $4. Baltimore.
Master Steam Fitter. *m.* $1. Chicago.
Min. and Sci. Press. *w.* $3. San Francisco.
Mechanical World. *w.* 8*s*. 8*d*. London.
Nature. *w.* $7. London.
North American Review. *m.* $5. N. Y.
National Builder. *m.* $3. Chicago.
Nineteenth Century. *m.* $4.50 London.
National Car Builder. *m.* $2. New York.
New Science Review, The. *qr.* $2. N. Y.
Paving & Mun. Eng. *m.* $2. Indianapolis.
Peterson Mag. *m.* N. Y.
Progressive Age. *s-m.* $3. New York.
Procd. Engineer's Club. *q.* $2. Phila.
Practical Engineer. *w.* 10*s*. London.
Plumber and Decor. *m.* 6*s*. 6*d*. London
Power. *m.* $1. N. Y.
Popular Science Monthly. *m.* $5. N. Y
Railway Age. *w.* $4. Chicago.
Railroad Car Journal. *m.* $1 New York
Railway Engineering and Mechanics *m.* $1. Chgo.
Railroad Gazette. *w.* $4.20. N. Y.
Review of Reviews. *m.* $2.50. New York
Railway Press, The. *m.* 7*s*. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s*. London.
Railway Times, The. £1. 5*s*. London.
Stone. *m.* $2. Chicago
Southern Architect. *m.* $2. Atlanta.
Sanitarian. *m.* $4. Brooklyn.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. N. Y.
Scribner's Magazine. *m.* $3. New York.
Scientific Quarterly. *q.* $2. Golden, Col
Stationary Engineer. *m.* $1. Chicago.
Social Economist. *m.* $1.50. N. Y.
Seaboard. *w.* $2. New York.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y
Steamship. *m* Leith, Scotland.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
School of Mines Quarterly. $2. N. Y.
Sanitary Record. *m.* 10*s*. London.
St. R'y. Elec. News. *m.* $2. Minneapolis.
Sanitary Plumber. *s-m.* $2. New York.
Street Railway Gazette. *w.* $3. Chicago.
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Safety Valve. *m.* $1. New York.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
Technology Quarterly. $3. Boston.
Transport. *w.* £1. 5*s*. London.
Trans. Am. Ins. of Mining Eng. N. Y.
Trans. of the Wis. Acad. Madison.
Western Electrician. *w.* $3. Chicago.

ARCHITECTURE & BUILDING

Bricks and Terra Cotta.

A SERIES of valuable articles upon the above-named subject has been running a number of months in *The Builder*, and has now reached the seventeenth number. This deals with bricks, their strength, absorptive powers, density, weights, hardness, etc., which, together, either by their presence or absence in varying degree, constitute the quality of bricks for building, paving, etc.

The limits of strength in bricks vary widely, and this quality, according as it is greater or less, is an index to their other qualities. But either as proof that bricks will resist the pressure to which they will be subjected, or as an indication of other important qualities, the test of crushing strength is less important than other tests, for reasons which follow. "The average brick of commerce, taken at random from amongst its kind, is not a regularly-shaped body. Even where a casual inspection might lead one to suppose that it was, the application of a rough micrometer shows that it would be the merest accident if all its sides and faces were even or relative in length. If measured on the flat, the height of its sides is but rarely found to be truly uniform all the way round. The dies of the machine between which the brick is crushed are, or should be, perfectly parallel to one another. From this it follows that such an irregularly-constituted body as the average brick is incapable of taking the pressure exerted by the machine and distributing it evenly over the surfaces applied to the dies.

"The projecting portions give way before the bulk of the material, the average strength of which is thus lessened, as it is also by the unequal strains produced." The use of soft wood, millboard, lead, etc., for imbedding bricks for crushing tests does not give best results. Of the materials named lead is probably the worst, as it flows under pressure more than any of the others. The best result—that is to say, the most accurate knowledge of the resistance which brick will oppose to crushing force—is obtained by the use of plaster of Paris, according to the method proposed by Professor Unwin, in which the brick to be tested is made substantially the core of a true parallelopipedon, the plaster supplying all defects in form. "No machine hitherto invented possesses strength enough to crush pieces of sufficient magnitude to invest the results with the importance they should have from a practical point of view. The only occasions an architect would be seriously called upon to calculate the strength of piers of brickwork, or, rather, the load they would safely carry, would be in the erection of a very large building, or in positions where they would be subjected to the pressure of heavy machinery, or of a large quantity of ironwork; and these are precisely the occasions on which feeble results of the crushing machine on very small piers (carefully made for crushing) would be of but little service. For the rest, the load that the smaller piers would carry should be sufficiently well known, from the experience of their more frequent use, to obviate the necessity for experiment on the subject."

The test for porosity is regarded as "the best all-round test to which bricks can be subjected. At first it might seem that it is the easiest of all the tests, but experience will soon show this to be a mistake. It is now generally recognized that there is an intimate relationship subsisting between the crushing strength of building stones, their specific gravity, and the relative amount of water they absorb; but, except in a limited sense, the same cannot be said for bricks and terra-cotta. The vitreous film produced on many kinds of bricks, whether distinctly visible, or only ascertainable on a micro-examination, is mainly responsible for the difference in this respect between bricks and stone; while local vitrification interiorly also impairs uniformity of results. Leaving that on one side, and looking at the matter in its broader aspects, it may at once be noted that a weak brick will usually absorb a great quantity of water, but it does not follow that a strong brick will not do likewise. Many bricks imbibe a large proportion of water, but will transmit hardly any; whilst others, equally absorbent, allow most of it to pass through. This is a property that does not appear to have hitherto formed the subject of direct experiment. Perhaps the best way to investigate it is to inclose the upper part of the brick in an impervious vessel, so that the former constitutes the base of the latter. The vessel is then filled with water to a definite height, when the column will sink as the brick allows the water to pass through. A graduated scale in the vessel and a time piece is all that is then required to register the rate of percolation. Care should be taken to thoroughly saturate the brick before commencing to read the scale, and, of course, it should be carefully set with as little cement as possible (which should also be tested), and so fixed that the water can pass through the brick only, and not through the cement as well."

The distinction here made between transmission and absorption appears to open a new lead in the investigation of the qualities of bricks from different sources. The capillarity of bricks has an important bearing upon dampness of walls. The usual methods of testing for capillarity—to wit, immersion wholly in water, or immersion leaving only one face exposed—may be extended with advantage to the determination of homogeneousness. "For this, break the brick in halves, and placing one half in half an inch of water as before (not on edge), observe the manner in which the moisture-line rises on the broken surface of the brick. If it rises in a tolerably straight line, the brick is fairly homogeneous; if, on the other hand (as is most frequently the case), that line is curved or irregular, it shows that one part of the brick is more absorbent than another. The deleterious effects produced by hard lumps in the material are well brought out by this method, especially if the water be chemically colored." This last is a very reliable and elegant method for the purpose intended. The topics of density, specific gravity, weight, and hardness are reserved for a future number of this series.

Tests of Building Stones.

A PAPER read by Mr. Lea McI. Luquer, Ph. D., on Feb. 20, before the American Society of American Engineers, and printed in the *Transactions* (No. 3, vol. xxxiii, March), contains an account of a series of careful investigations to develop the relation between two methods of testing building stone,—to wit, frost tests, and sulphate-of-soda efflorescence tests. The recent establishment of artificial storage warerooms has afforded increased facilities for conducting frost-tests, and a comparison between the results of the two methods can now be readily instituted. The paper contains a preliminary enumeration of experiments performed both by freezing and by the sulphate-of-soda method, before entering upon the description of the special tests brought before the society. This list, and the foot-notes referring to the publications wherein they are described, form a considerable bibliography of the subject. The process employed in the special tests described was that of Brard as modified by d'Hericart and de Thury. (*Chateau. Tech., du Bâtiment, Vol. I, p. 272.*)

"A saturated cold solution of pure sulphate of soda (Glauber salt) was used, great stress being laid by de Thury on the solution being saturated cold. Experiments made by the French inspector-general of quarries have demonstrated the fact that stones which will resist frost and the action of cold saturated solution of lye are entirely broken up by the action of a hot saturated solution. Experiments made by Dr. Valté, of the School of Mines, on concentration of soda solutions developed the following fact: when getting a hot saturated solution of this salt, the temperature of the solution will rise above 212° F. (100°C.), and will keep going up until finally it passes what may be called the 'critical temperature,' when decomposition will take place, S_2O (sulphur dioxid) being driven off and Na_2O (caustic soda) being left behind, which may have the solvent action of an alkali on the silicates in the rocks. Decomposition will apparently also take place in the case of the limestones. The normal cold saturated solution of sulphate of soda is of course neutral. Former investigations all demonstrate the necessity of using a cold saturated solution."

The specimens, fourteen in number, comprising the different kinds of stones commonly used in building, such as marble, limestone, granite, gneiss, trap, sandstone, and brick, were "carefully prepared, brushed, dried, and weighed," and "were boiled in the sulphate of soda for half an hour, in order to get complete saturation. At the end of the half hour, it was noticed in every case that the solution was slightly alkaline, although at the start it had been neutral. In order to prevent any continued chemical action, the beakers were emptied, the specimens rapidly washed with water, and the beakers immediately refilled with the neutral sulphate solution. After soaking for several hours, the specimens were hung by threads, and left for 12 hours (during the night) in a dark room.

"In the morning all the specimens were covered with an efflorescence of the white sulphate of soda crystals; they were then allowed to soak in the solution during the day, and again hung up at night. Efflorescing for about 12 hours and soaking for about the same time constituted a period. The experiments lasted for eight periods, and were conducted in this way in order to make them correspond with those with freezing water, as in the cold storage room the specimens could only be changed night and morning." The temperature of the cold room was from 4° to 10° F. (—16° C. to —12° C.), and the specimens were left to thaw and soak during the day in a room with the temperature at about 85° F. (30° C.) After the completion of the tests the specimens were allowed to soak in water for as long as it took to remove all traces of sulphate of soda in the other series of experiments, after which they were carefully dried and weighed. During the progress of these experiments the deterioration was so slight that the effect was scarcely noticeable, the sandstones only showing the effect by a slight residue in the bottom of the pails in which the experiments were made. The results are given in tabular form." These show that, except in the case of the sandstone specimens, notably decomposed sandstones, the losses were small, and that they were less by the frost test than by the efflorescence test.

In the discussion—several members taking part—Mr. L. Le Coppet Berg, speaking as an architect, stated among other things that "it was customary with his profession to select a stone on account of its beautiful color, or because it harmonizes with its surroundings, or on account of a desired finish which it will readily take,—first, of course, making as sure as possible, by the opinions of experts, that the stone will weather well. When the stones are built in, every precaution is taken to get them of even quality, on their natural bed, etc., and yet after one winter's exposure, frequently, certain stones will begin to show discolorations, and, as year after year goes by, will deteriorate more and more, until, after 7 or 8 years, they are almost entirely disintegrated, although most of the neighboring stones are perhaps still perfect." He therefore wished to ask the author if there was any simple practical test, which could be applied at the building, to find out whether two stones of apparently the same quality were actually so.

In closing the discussion Mr. Luquer replied that he did not think such a test could be devised. He further stated that tests made by Mr. Gerber, by both of the methods compared, and communicated to the society at the same meeting, "corroborated very closely the results obtained in his own series of experiments, and emphasized the fact of the undoubted stronger action of the sulphate of soda."

Architectural Aberrations.

WHEN in this department of our February number we criticised the architectural incongruities embodied in the design of the "Cairo" apartment house, in Washington, which had been indiscriminately praised by a contemporary, we were not so fortunate in finding a name for this sort of work as *The Architectural Record* for May and June has been. "Architectural Aberrations" is the title of a series of papers now running in the magazine named; and in No. XIII. of this series the Cairo building is thus ranged under an already large category. With the public offensiveness of many buildings like the Cairo, this series is dealing without fear or favor. "There is a patent absurdity in taking thought and spending vast sums of money for the purpose of making a harmonious city, and then permitting any promiscuous private person who can get possession of a piece of ground, and raise money enough to put a building on it, to nullify all your dispositions and vulgarize your town." And of the "Cairo" in particular it is said that a stranger visiting Washington not long ago might have thought, "here is a town that is at least secure from the sky-scraper. He might have said this even a year ago, when he would still have been confident that no vandal would put up an example of the Chicago construction in Washington, because the intelligent vandal would be convinced that, where land was so abundant and expansion of area so easy, the sky-scraper would not pay. Alas! he can say so no longer. A vandal has been convinced that the sky-scraper would pay, and, being unrestrained by statute or propriety, has carried this revolting notion into execution. The result is the *Cairo*, the present aberration. 'A ten-story building in a ten-acre lot' is necessarily an architectural aberration; and a twelve-story building in a city of magnificent distances is a contradiction in terms. It does not so much matter what kind of a building it is. The owner might have employed an artistic architect, and the architect might have produced as admirable a building as the Dakotah in New York—distinctly the most successful of the lofty apartment houses. The owner would still be a public malefactor, and the architect an accomplice in a public offence which is not punishable by law only because we are too imperfectly civilized to punish public offences of the esthetic kind. Our ears and noses are the objects of judicial solicitude, but not our eyes. A man may not establish a soap-boiling establishment, or a slaughter-house, or a boiler-shop, in a quiet residential quarter, but he may put up a sky-scraper and none can say him nay. We whip the devil around the stump, when a man raises a stench or a clatter, by pretending that it is dangerous to health, which is mostly bosh, both as to the soap-factory and the boiler-shop; but, when he constructs any eye-sore, we can do nothing except relieve our feelings in print, as in the present instance." . . . Granted—what no reasonable or humane person will ever grant—the propriety or necessity of a sky-scraper in Washington, what kind of sky-scraper is the Cairo? It is the worst kind. There is only one malefactor concerned in the designing of it, for the owner, it seems, is also the architect. That is satisfactory, for one likes to think ill of as few fellow-creatures as possible. It would be more satisfactory if there were any evidence that the owner had applied to artistic architects to help him gild his pill, and they had particularly refused to abet him and left him to bear the odium alone. But there is no real reason to think so well of the practitioners of architecture. They are too apt to say with the owner, *il faut manger*, and the answer is equally obvious and familiar in each case. At any rate the pill is ungilded. The building is a box, and the combined owner and architect has done nothing to mitigate its boxiness. . . . It is a box full of holes. . . . It is curious how the effect of boxiness, inherent in the original parallelopiped, is enhanced by all the things the architect has put on it ostensibly to relieve it of that appearance. The balconies at the angles at the centre, and between the two, are merely box-like troughs, and so is the cornice a mere projecting box. It almost seems as if the designer must have projected these boxes in a cynical spirit, as if, instead of trying to mitigate the boxiness of the building, he were intent upon aggravating it and 'rubbing it in.' Upon the whole, we decidedly prefer the side, where he has not pretended to do any architecture, to the front, where he has made his unsuccessful pretensions in that direction. The side is an ugly object, a very ugly object, but it makes no pretensions, and thus escapes vulgarity. It is the pretension of being an architectural work that makes the front so exasperating, when it is, as evidently as the side, a box." In conclusion, it is a "shameful fact that there has been no way found of preventing the erection of the Cairo in the capital of the United States."

Use and Abuse of Marble.

A DISCUSSION upon the use and abuse of marble for decorative purposes, which occupied an evening at a recent meeting of the Institute of Architects, is reported in *The Architect and Contract Reporter* (April 26). The discussion was opened by Professor Atchinson, who said the objection to the use of flowered marble for columns that bear weight was its liability to flaws and defects. Such shafts, before being placed, ought to be tested for strength by the hydraulic press.

"With regard to the internal use of marble in England, it looked and felt cold in winter, and, when buildings were not warmed, it condensed the damp. Marbles mainly formed of carbonate of lime were useless externally, as the polish rapidly perished. The use of marble for decoration was to color harmoniously by means of a particularly beautiful and specially-colored material. The finer-flowered sorts had in their coloring every sort of motive and caprice that could astonish and charm." The professor then described the colors of different marbles, and referred to the imperishable colored decorations to be obtained by inlaying. "Monumental color was as hard to get as monumental form. The safest course was to adhere to one color, or to some strong contrast of two colors, such as black and white, or dark green and white. Black and white for columns, balustrades, and walls had a dignified effect, but the white should greatly predominate, or the effect would be too funereal. If an effect of richness, magnificence, or gorgeousness, or of delicacy or loveliness, were required, the same rules held good in marble as in painting. For a white or a light ground, with color interspersed, the other colors should be very light, or bright colors in small pieces; while for a dark or low-toned ground white or very light tones should be sparingly used." The successful use of colored marbles for decorative effects require what Professor Atchinson regards as "a rare gift,"—the "natural ability to harmonize colors perfected by study, observation, and practice."

Mr. William Young followed in the discussion, and spoke of the now largely-increasing use of marble for English interiors, and intimated that much of this work was faulty. He thought the true use of marble meant something more than merely lining walls with slabs of that material, set in courses marked off by horizontal and vertical joints after the manner of the marble wall-papers with which the walls of the passage and stairs of every ordinary house used to be covered. In marble, as in other materials, the architect should follow a certain order and scheme to bring out his design. The labor of the hewer, the sawer, and the polisher revealed the beauties of marble; thought and skill must be added to make it beautiful in architecture. To explain his meaning, the author referred to the arrangement of the marbles represented in Mr. Alma-Tadema's picture, "The Roman Bath." For use in a large way, marbles should be few, but well chosen. With three or four different marbles, handled by a master, there was nothing within the range of architectural art, from simplicity to magnificence, that the architect could not accomplish. In selecting marbles for columns, arches, &c., it was sometimes exceedingly difficult to get the particular type wanted to insure perfect harmony. Instances within the author's own experience were cited. Columns should be constructive, and not planted on for decoration; if possible, they should be monoliths. Square pillars should be solid marble, and not brick-cased with marble slabs jointed to imitate solid masonry. The marble on walls, where solid blocks would be useless waste, should be so treated as to show that it was lining. Ordinary box-marble chimney-pieces, consisting of slabs of marble placed one in front and one on each side, as though to give the appearance of a solid block, the author considered not to be true use of marble, and not architecture. With regard to the question, "Should Color Follow Form?" the author was of the opinion that there was much sound truth in Mr. Ruskin's dictum that color should be visibly independent of form, although in actual work it was found that color, as a rule, must follow form. There were, however, exceptions.

Wind Pressure.

THE discussion of wind pressure and its effects upon structures of various forms is active. Scarcely have we laid down one publication in which the debate has been opened before we take up another which continues it upon a different, if not an original, line. The question will doubtless at some time in the near future be settled experimentally,—the only method by which it can ever be authoritatively settled. In fact, experiments already performed have gone far toward settling it. They show that under certain conditions wind pressure—that is to say, unbalanced wind pressure—may far exceed what was only a few years ago considered the maximum.

Indian Engineering (April 13) says that, far "from being a question whose interest is mainly theoretical, many accidents which have occurred to large roofs are directly attributable to the extraordinary negligence often shown by failure to apply known facts to some particular case under consideration. The mistake does not consist in a wrong estimate of the total resultant thrust on any building or roof due to wind pressure against one side of it. The usually accepted formulæ will give with sufficient accuracy the total horizontal pressure against a structure exposed to wind of a given velocity; it is the distribution of pressure over different parts of the structure concerning which there is so much popular misapprehension."

"When the average newspaper reader sees an account of some roof being blown off by the wind, his idea probably is that the wind got underneath it somehow and lifted it up. *The Engineer* will scarcely share this opinion, but, nevertheless, his roof's design will very probably indicate as little knowledge of the subject as would be argued by such a belief."

The pressure of a moving fluid against any obstacle which it surmounts and passes is but partially composed of the direct pressure due to the impact of the fluid against its exposed face. A large portion of the total—often by far the greater portion—is represented by a negative pressure on its sheltered side, due to rarefaction of the fluid to leeward. Noticeable when we observe a heavy and incompressible fluid, such as water, this is particularly marked in the case of a highly elastic and extensible fluid, such as air. An article by Irminger in the *Ingenipren*, Copenhagen, detailing experiments made on the subject, is very valuable as giving quantitative results which enable the general principle to be readily applied to actual cases; and from it we see how much more considerable than is commonly supposed is this complex character of wind pressure.

These experiments made by Irminger, referred to in the quotation, have shown quite conclusively that the shapes of structures independently of their projected areas facing the direction of the wind have much to do with the effects of wind upon them.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*30997. Architectural Aberrations.—The Cairo. Ill. (Arch Rec-April-June.) 1800 w.

*31620. The Architecture of Railroad Stations. Ill. Bradford L. Gilbert (Eng Mag-July.) 3000 w.

*31632. The Use and Abuse of Marble for Decorative Purposes (*Arch*-April 26.) 1200 w.

31664. A New Reducing Instrument for Perspective. Ill. Alfredo Melani (Am Arch-May 11.) 2000 w.

We supply copies of these articles. See introductory.

*31668. Door Decoration. Ill. H. Leslie Ramsey (*Plumb & Dec*-May.) 600 w.

*31669. Mural Decoration. Maurice Greeley (*Plumb & Dec*-May.) 1200 w.

31710. Artistic Decoration.—The Treatment of Modern Residences and First Class Buildings (Bos Jour Com-May 11.) 900 w.

*31734. House Building Hints (*Ill Car & Build*-May 3.) 1500 w.

†31758. Wind Pressure. Editorial (*Ind Engng*-April 13.) 900 w.

31800. Novel Foundations of the Marquette Building. Ill. From Carpentry & Building (Ir Age-May 16.) 600 w.

31836. The New Tenement House Law. Editorial (Arch & Build-May 18.) 1500 w.

31912. Sound in Its Relation to Buildings. H. W. Burrows (Am Arch-May 18.) 11000 w.

31959—$1.50. Wind Bracing in High Buildings. Guy B. Waite, with Discussion (Am Soc Civ Eng-March.) 17500 w.

31960.—$1.50. The Relative Effects of Frost and the Sulphate of Soda Efflorescence Tests of Building Stones. Lea McI. Luquer, with Discussion (Am Soc Civ Eng-March.) 8000 w.

†32061. Municipal Building Laws. Dankmar Adler (In Arch-May.) 4000 w.

†32062. Soap and Water in Relation to Architecture. P. B. Wight (In Arch-May.) 800 w.

32066. Foundations for Tall Buildings.—The Problem That Had to be Solved to Secure Stable Ones (Bos Jour Com-May 25.) 1100 w.

*32076. Slow Burning Buildings. William McDevitt (Arch Build & Dec-Feb.) 900 w.

*32077. Terra Cotta. Anon. (Arch Build & Dec-Feb.) 1100 w.

*32079. Points in Acoustics. David Gunn Baxter (Arch Build & Dec-March) 1700 w.

*32102. Exhibition by the Electric Fireproofing Company.—Deductions. F. E. Cabot (Br Build-May.) 1300 w.

*32103. Why Do They Crack? Ill. Will I. Nott (Br Build-May.) 1300 w.

†32154. The New Public Library in Boston. Ill. I. Its Artistic Aspects. Mrs. Schuyler Van Rensselaer. II. Its Ideals and Working Conditions. Lindsay Swift (Cent Mag-June.) 6500 w.

*32174. Some Sussex Churches. H. Goodall Quartermain (*Brit Arch*-May 24.) 3200 w.

†32233. Brickwork and Masonry in Ancient Times in India. J. D. M. B. (*Ind Engng*-May 4.) 3000 w.

32239. The Deterioration of Modern Workmanship.—Failure of a Conference Called to Discuss the Matter (Am Arch-June 1.) 3000 w.

32314.—75 cts. The Colonial Style of Architecture. William Danmar (Tech Quar-Dec.) 2000 w.

*32364. The Influence of Architectural Style upon Design. Ill. Walter Crane, with Discussion (*Builder*-June 1.) 1000 w.

*32365. Lindisfarne Priory. Ill. Charles C. Hodges (*Builder*-June 1.) 3000 w.

Serials.

12568. Building Construction and Superintendence. F. E. Kidder (Arch & Build-Began May 6, 1893—42 parts to date—15 cts. each).

18737. The Engineering of Architectural and Building Construction. Ill. William H. Burr (Eng Rec-Began June 6, 1894—11 parts to date—15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (Br Build—Began Jan., 1894—17 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (*Plumb & Dec*-Began March, 1894—15 parts to date—30 cts. each).

21288. Theatres. Ill. E. A. E. Woodrow (Am Arch-Began April 14, 1894—16 parts to date—15 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (Br Build-Began April, 1894—13 parts to date—30 cts. each).

26069. Modern Steel Fireproof Construction. Ill. F. M. Small (Arch & Build-Began Oct. 13, 1894—7 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. W. J. Eden Crane (*Ill Car & Build*-Began Nov. 9, 1894—9 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (Arch & Build-Began Nov. 24, 1894—7 parts to date—15 cts. each).

28494. Bricks and Terra Cotta (*Builder*-Began Jan. 5—19 parts to date—30 cts. each).

29253. The Guilds of the Medieval Workers in Stone. Edward C. Weaver (Stone-Began Feb.—4 parts to date—30 cts. each).

29578. On the Use of Brick in Domestic Architecture. Ill. Ralph Adams Crane (Br. Build-Began Feb.—2 parts to date—30 cts. each).

31085. Notes on the Polychromatic Decoration of Churches. George Ashdown Audsley (Arch and Build-Began April 20—3 parts to date—15 cts. each).

31319. The Modern Office Building. J. Hollis Wells (Br Build-Began April—ended May—2 parts—30 cts. each).

31688. Painting, and Its Relation to Architecture. C. W. Whall (*Builder*-Began May 4—ended May 11—2 parts—30 cts. each).

31880. Practical Masonry and Stone-Cutting. Fred T. Hodgson (Stone-Began May—1 part to date—30 cts.)

31911. The So-Called Colonial Architecture of the United States. Ill. O. Z. Cewin (Am Arch-Began May 18—3 parts to date—15 cts. each).

32100. Terra Cotta or Stone. Thomas Cusack (Br Build-Began May—1 part to date—30 cts).

32206. The Blackpool Tower. Ill. (*Engng*-Began May 24—1 part to date—30 cts).

32261. A New Departure in Engineering. Ill. (Eng Rev-Began May 20—1 part to date—30 cts).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

The Late Arthur Mellen Wellington.

In the death of Mr. Arthur Mellen Wellington, late editor of *The Engineering News*, the profession of civil engineering and the country at large have sustained a severe loss. As one of the heads of an influential engineering journal he was best known to the general public, and in this position his exceptional talents as an engineer, a writer, and an editor have done perhaps as much as those of any one who could be named for the advancement of the profession and the dissemination of sound principles. These efforts were directed, not only to the improvement of general practice, but also to elevation of the ethics of the profession.

Advance proofs containing a well-prepared biographical sketch of Mr. Wellington were forwarded to us by *The Engineering News*, arriving too late to be available for our June number. We are, however, glad to assist in honoring the memory of a man so worthy of honor, and herewith present the outlines of a life wholly worthy of emulation.

It is not given to many men to leave so many "footprints on the sands of time" as Mr. Wellington did. His life was one of ceaseless activity, and, when the blows of his hammer fell, an impression was always made.

"Arthur Mellen Wellington was born in Waltham, Mass., December 20, 1847. He was descended on his father's side from an old New England family, which had resided on a rocky hillside farm in the town of Lexington, Mass., since colonial times. In physique he was the very opposite of the typical Yankee, having a sturdy, well-proportioned frame; but his nervous temperament and his never-failing store of energy well indicated his New England ancestry. He graduated at the Boston Latin School, and then, when only 16 years old, began the study of civil engineering in the old-fashioned way" as an articled apprentice in the office of John B. Henck, of Boston, the author of Henck's Field-Book.

"He found time to pay some attention to mechanical engineering, and he passed an examination for a position as assistant engineer in the navy, but was not appointed on account of the ending of the war." His first engagement was in the engineering corps of the Brooklyn Park Department, under Mr. Frederick Law Olmsted, as leveler and assistant engineer. In 1868 he obtained his first position in railway work, on the Blue Ridge R. R. in South Carolina, as transitman, having charge of a locating party. He then went to the Dutchess and Columbia R. R., in New York, as an assistant engineer. When he was 23 years of age, he was placed in charge of a division on the Buffalo, New York, and Philadelphia railroad, and was soon advanced to the position of principal assistant. After 2½ years, he became locating engineer of the Michigan Midland railroad, and later was engineer-in-charge of the Toledo, Canada Southern, and Detroit railroad.

"Mr. Wellington's first literary venture was made in 1874. It was in 'The Computation of Earthwork from Diagrams,' a book which was the outcome of the methods he had worked out for expediting his own computations in the works in which he was engaged. This book was very favorably received. . . . His great work,—that by which his fame as an engineer was firmly established,—'The Economic Theory of the Location of Railways,' was begun in 1875, and was first published in the *Railroad Gazette* in the latter part of 1876, as a series of articles on 'The Justifiable Expenditure for Improving the Alignment of Railways.' These articles were reprinted in book form in 1877, and the attention of engineers and railway men was at once attracted to their writer as an engineer of uncommon brilliancy and ability."

A long list of subsequent practical and

literary work filled the interval between 1877 and 1884, in which year Mr. Wellington took a place on the editorial staff of the *Railway Gazette*. Some of this work called Mr. Wellington to Mexico, where he spent 3 years previous to his engagement on the staff of the *Gazette*. During his term of service on this publication Mr. Wellington did much of the best kind of literary and professional work. The engagement was discontinued in January, 1887, Mr. Wellington becoming part owner and one of the editors-in-chief of *The Engineering News*. The influence of his energy and ability was at once seen in every department of this journal. Within two years its subscription list had more than doubled, and the paper had become a recognized authority in departments which it had theretofore hardly essayed to touch. In his editorial work he combined in wonderful measure the two valuable qualities of originality and industry.

"Of the work which engrossed the last 2 years of his active life we may not speak fully at this time; but, as the record of his life would be incomplete without it, we cannot pass it wholly by. In the summer of 1892 he took a vacation of 3 weeks, but, instead of leaving the city, as was his usual custom, he devoted his leisure to working out some ideas in thermodynamics which had occurred to him years before. The result of his study was the invention of an entirely new type of thermodynamic engine, designed to convert heat into mechanical work with a much smaller percentage of loss than the best existing steam engines.

"In his labors upon this latest child of his brain, his eagerness was such that he was no longer able to turn his thoughts away from it, even in the few hours which he allowed himself for rest; and there were nights when the dawning of morning found him still busy at his desk. Even his iron constitution could not bear up under such strain, and early in 1894 he found himself physically unable to go on with his work."

From this time Mr. Wellington never regained his health. "On April 25, at a consultation of physicians, it was decided that an operation for the removal of a diseased kidney was necessary, and it was performed on May 15 with success. But, besides the disease at this point, there was a chronic weakness of the heart, and at 9.30 P. M. on May 16 the organ refused to perform its work."

In all that go to make up an admirable man Mr. Wellington was richly endowed. A splendid physique, a powerful mind, a cheerful, happy disposition, fidelity to friends, sterling principles,—all these were his; and the regrets of all who knew him have followed him to his final resting-place.

Cement Testing.

THIS subject never loses interest with engineers. So many anomalies manifest themselves in the behavior of cements; there is yet so much to know about them; their qualities—including all their tricks and manners—are so intimately related to the permanency of the most important engineering constructions,—that no more vital question exists in the whole line of civil engineering than cement testing. The assurance that his materials are all right is most anxiously sought by the trained and experienced engineer. On his own ability he can rely; experience has taught him self-confidence; but the materials—unless he can make sure of *them*, he stands on slippery places; and of all the materials he has to use cements are the most likely to fail him at some time and in some place.

One of the best papers on this subject which it has been our fortune to meet with was read before the Canadian Society of Civil Engineering by Mr. Cecil B. Smith, and printed serially in *The Canadian Engineer*,—the first part in the May number. The persistent and continual investigation of this inexhaustible mine, and the disagreement of investigators, are spoken of as illustrating how little the subject is understood, and the failure, up to the present, to solve all the intricate mazes of the problem. The paper is a long one, and in it is compressed a mass of important and curious facts. A large portion of it is devoted to a tabulated statement of results of tests of Canadian, English, and Belgian Portland cements, which were carried out in 1893-94 by a committee of the society.

The points of interest which impress the reader at the first perusal are the proposed mode of conducting tests, and some anomalous behavior met with in some of the samples tested. We will indicate herein some of the leading points, with the preliminary statement that the remarks made upon each, which we must for the most part omit, go far to substantiate the propositions made by the author. The average specific gravity of Canadian Portlands is given as 3.11; of English, 3.10; of Belgian, 3.055. The average specific gravity of all Portlands is 3.09. It is therefore advised to specify, as a minimum for Portland cement, a specific gravity of 3.10.

"The water required for standard consistency is considered by many to be very important, but many tests have been demonstrated to the writer that what is especially needed is that there shall be sufficient to make good briquettes; to err, say 1 per cent., in adding water is fatal, if too little, while, if too much, it does not seem to affect the strength of briquettes at 1 week, certainly not at 4 weeks. This is contrary to statements often made regarding the increased strength given by a minimum amount of water; but probably what is referred to is an excess of water sufficient to make a thin batter soup. Undoubtedly such an amount not only makes the briquettes shrink and crack in drying, but will seriously affect the early strength.

"A very peculiar effect was met with in two Canadian Portlands and one English. They were evidently fresh, and, when mixed with a normal amount of water, would work into a good plastic mass, but in about one to two minutes after the water was added, they would suddenly set so hard that it was useless to attempt to put them in the moulds. By increasing the per cent. of water to about 30, a thin batter was made, which could be got into the moulds before this action took place; of course this amount of water made the set very slow, and deadened the indurating action in one-week tests. When tests were made on these cements several weeks later, this effect had disappeared; perhaps some one connected with this industry can explain the cause of this action."

In residues or fineness the variation is enormous. On a No. 80 sieve there remained only 2.7 per cent. of one, while of another there remained 52.2 per cent. On a No. 50 sieve there remained of one sample 0.25 per cent., while of another sample 31.4 per cent. was left. On a No. 120 sieve, of one sample the residue was 6.7 per cent., while of a compared sample the residue was 61.20 per cent. English Portlands are generally coarse; selected Canadians are, on the contrary, fine. The author urges the severest requirements for fineness.

"The time of incipient and final set, as found by Gilmore's needles, does not seem to affect the strength, except for short tests. While the slow-setting cements are generally stronger, good cements may be either slow-setting or quick-setting; but ordinarily, unless for tidal work, a slow-setting cement has the desirable features of allowing masons to mix and use good-sized batches of mortar without constant tempering, as practised with quick-setting ones, much to their hurt.

"The blowing test advised by Faija has detected a 'blowey' tendency in several instances; but much late evidence seems to throw some discredit on blowing tests, whether made with hot or boiling water, on the ground that manufacturers can, by the addition of sulphate of lime, cause the cement to be so slow-setting and set so strongly as to resist the blowing tendency of so much as 3 per cent. of free lime added after the cement has been burnt. If this is a fact, chemical analysis will need to be resorted to more frequently to detect this dangerous adulteration, which is fatal in sea water, and bad in any case, as the great strength which it gives to cement at early dates is apt to decrease at longer periods. Belgian No. 19 cement, tested, gave higher results at 1 week than at 4 weeks; this looks a little suspicious."

Cement should be tested when in the same condition as that in which it is to be used. The present German method is to use mixtures of 3 to 1, and this is approved. Great difficulty is experienced in getting anything like uniformity in sand-tests.

"The variation in putting the mortar in the moulds has been so much more than the variation in the cementing value of the cement that the tests were valueless, so that most testers have clung to neat tests as being simple and a fairer index of cementing qualities. This view is in fault, and misleading."

As a result of the tests made by the committee (Mr. Smith is a member of this committee), 20 per cent. of water is regarded as "just sufficient to make a plastic mortar, so that a good briquette can be formed, while more water tends to drown the cement and make it weaker at both the 1-week and 4-week tests, although longer tests would probably show a recovery in this respect. This proportion of water applies to 1 to 1 and 3 to 1 mixtures, and will probably be about right for 2 to 1."

"It is conclusive that, if any standard test under light pressure is to be adopted for sand tests, 20 per cent. of water must be prescribed as a definite part of the test, and in this way perfect uniformity obtained. It is understood that the sand used is standard sand, dry and sharp; a finer or rounder sand would allow less water to be used. This amount of water, while greater than that usually given by authorities whose method of making sand briquettes is by some severe hammering process (German), is still close to the amount used in practice." The object is to "approach as nearly as possible to actual usage, and fortunately the two conditions are in harmony with each other." The pressure adopted in the tests was 20 lbs. per sq. in.

Failure of the Manchester Ship-Canal Enterprise.

UNDER the title "The Beginning of the End," *The Railway Times* (May 4) editorially reviews the embarrassments which have fallen upon the Manchester ship-canal enterprise. The lesson is a hard one to the Manchester rate-payers. It will be remembered that the project completing the canal at the expense of the rate-payers was accepted with enthusiasm by these willing victims, notwithstanding the fact that they were warned by *The Railway Times* and other papers that it was "a dangerous new departure in finance."

In 1891, under the title "Manchester Martyrs," the paper quoted said: "It is satisfactory to note that the Manchester corporation does not wish to make money out of the necessities of the canal company. 'A strong feeling exists,' says the committee, 'that the arrangement should preclude the possibility of any profit accruing to the corporation in any event, and we believe that this may be practically attained.' We venture to think that the corporation will find but little difficulty in avoiding a profit on its ship-canal speculation."

Now it says that "events have moved rapidly since 1891. The canal has been carried to completion, or to something approaching completion. It has been opened for traffic throughout its whole length by her majesty, the queen; and the traffic receipts have been what we always predicted they would be,—miserably inadequate to the pretentious magnitude of the undertaking. It will occasion no surprise to readers of *The Railway Times* to hear that the company is about to ask the Manchester city council to forego the interest on the £5,000,000 sterling of public money which have been sunk in the canal. Necessity is a stern taskmaster, and, although the canal company may go through the polite form of asking the city to forego its interest for a time, probably most of the city fathers whose municipal patriotism has brought Manchester into such an unpleasant predicament have realized ere now that the interest must be foregone, whether the city likes it or not. 'It is ill taking the breeks off a Hielandman,' says the Scottish proverb, and certes it were as profitable to attempt to draw blood from a stone as to extract money from the Manchester Ship-Canal Company. It may be asked, however, whether foreclosure is not likely to prove more profitable to the city than the temporary waiver of its right to interest on the money lent. We shrewdly doubt it. The loss of £5,000,000 is a very dismal business, but the assumption by the city of Manchester of complete control of the canal would infallibly mean throwing good money after bad. Where funds can be raised by the simple expedient of a small addition to the rates, there would always be the temptation to further expenditures, and probably it would be cheaper to write the £5,000,000 off as a bad debt than to saddle the municipality with the endless expense and responsibility of so vast an enterprise. It must be interesting to the unfortunate shareholders to read that a representative of the French government has been surveying their property with a view to the improvement of the navigation of the lower Seine. If Johnny Crapaud could only be persuaded to buy the canal right out at a reasonable price and transplant it bodily to France, he would confer a boon upon the suffering shareholders, and materially improve the health of Lancashire. Meanwhile the rate-payers of Manchester are in the untoward position of having advanced £5,000,000 sterling on a security not worth foreclosure. Notwithstanding the greatness of their services to the undertaking, they are only third mortgagees for £1,359,000 of first debentures,—repayable, by the way, at par, on January 1 next,—and £600,000 of second debentures rank in front of their bonds." It seems truly pitiful that an enterprise so vaunted as this has been in the past, and which, from an engineering point of view, is of so much interest, should thus have become a target for the shafts of satire. The effects of the failure will be hard enough for those to bear who must suffer from them, and these are, presumably, not alone the Manchester rate-payers.

Improved Tent Flap and Lock.

ANYTHING which claims to add to the comfort and convenience of engineers in field-work that necessitates camping out—often for weeks and months—is sure to attract the attention of the entire profession, provided that, *prima facie*, it shows some merit. Such a device, it appears to us, is one illustrated herewith, and described in *Engineering News* (May 9). It is an improved tent flap and fastening recently invented by Mr. Jas. J. Rinn. By means of these devices, which are stated to have been patented, the entrance flaps of tents may be tightly closed against both wind and rain, and also against meddlesome or intrusive people.

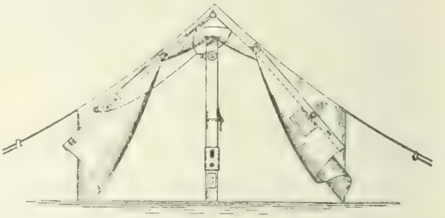


FIG. 1. FRONT VIEW OF RINN TENT

"A rigid strip is fastened in the edge of one or both of the entrance flaps, and means are provided for securing these strips to the tent-pole, as indicated in Fig. 1. Either one flap or both can be converted into doors, as required. The strips are connected to the upper end of the tent-pole by a universal, yet detachable, joint (Fig. 2), in such manner that the strip and its flap can be swung aside, merely providing an entrance; or both strips can be detached from the tent-pole and a wide opening made, as shown in Fig. 1. The horizontal slit in the canvas required for this purpose is opened or closed by cords provided, and a hood closes this opening against wind and rain.

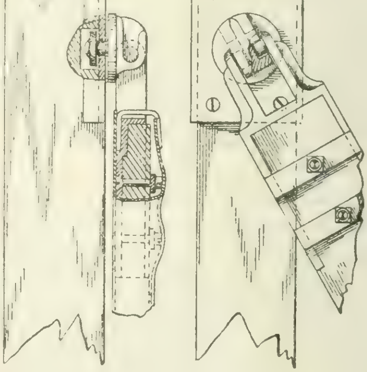


Fig. 2. Connection Between Tent-Pole and Rigid Piece in Tent Flap.

"To fasten the tent, a mortised bolt is firmly secured on the rigid strip at about the height of a door-latch, and to the front of the tent-pole is fastened a locking or latching device. In the side of the lock is a push-button, always accessible from the inside and reached from the outside by inserting the finger in a slit provided in the canvas. The insertion of a pin into this lock makes it secure against entrance from without, and, by using a padlock on a hasp, the rigid strip can be locked to the tent-pole when the owners of the tent are absent.

"Similar means are provided for securing the tent when both flaps are to be used as doors. These appliances may be adapted to both ends of the tent, and by an ingenious arrangement Mr. Rinn provides for the use of mosqulto- or fly-nets in connection with these doors."

These devices also obviate the beating and wearing of tent flaps which occur in windy weather. Very little weight is added to the outfit, and the strips are readily detached from the pockets and lashed to the tent-pole when getting into marching order. A modification of the devices adapts them to round tents and to those which have no tent-pole at the entrance. Mr. Rinn some time ago exhibited these tent appliances to us, and we were favorably impressed with them, having personally experienced some of the annoyances they are intended to obviate.

The "Jumbo."

A NEW device, if in these days of rapid progress anything invented 10 years ago can be called new, is described in *Louisiana Planter* under the title "Irrigation by Wind Power in the West." *Scientific American*, May 18, has reprinted this article. "There is in the west a vast, nearly level plain, with not a wind break from the north pole to the gulf, with but little wood or coal, with considerable, but not sufficient, rainfall, with fertile soil, and a necessity for elevating the water for irrigation. Clearly there is need there for a cheap, simple, effective invention for elevating water. Everywhere in Western Kansas may be seen windmills of primitive form, horizontal, vertical, or vertical-geared. Holland has 12,000 windmills, which average 8 h. p., used to drain the polders. The States of the plains will soon apparently have more than that number used to irrigate the prairies. Steam pumps, gas engines, hydraulic rams and pumps driven by animal power, and all of the known devices for elevating water, are now finding experimental tests in Kansas. It is probable that valuable data in regard to comparative cost and efficiency of these different motors will be obtained from these tests."

"A crude invention, which is called the 'Jumbo' wind engine, appeared in Western Kansas about 10 years ago, and is now coming into extensive use; its ease of construction, economy in cost, capacity in power, and simplicity, seem to recommend it to those who observe its work. It resembles the paddle-wheel of a stern-wheel boat, with a shaft 12 or 14 ft. long, with a diameter of 12 or 16 ft., with six or eight radial arms. The lower half of this horizontal wheel is shielded from the wind, so that the air acts only upon the upper vanes. A crank upon one end of the shaft connects with a pump. Its power can be indefinitely increased at any time by increasing its length, which can be done by anyone who is handy with tools. It is said that a 'Jumbo' giving 100 h. p. in a 15-mile wind can be put up at cost of $500. The wind acts upon this sort of paddle-wheel from all points of the compass except two. It seems to require no 'governor,' but simply pumps more during the storm. No tower is required, and it is placed so that the radial arms will be clear of the ground. In fact, in Kansas, where there are few trees and no hills, it is claimed that the wind currents have greater force at the surface than high in air. Perhaps in this crude device for raising water for irrigation in a wind-swept country there is the germ of an idea which, when fully developed and perfected, may become widely useful. If so, it will be quickly improved, for it is watched by many eager and anxious eyes, and now the development of an implement requires days where formerly centuries were needed. The crude 'Jumbo' of to day may become the perfected irrigating machine of to-morrow in level and treeless sections."

The above contains all that is pertinent to the subject named in the title. The article is a curious jumble of talk about bicycles, ancient methods of raising water, overshot water wheels, etc.

A CONCRETE bridge, having a clear span of 164 feet and 26 feet wide, was recently constructed over the Danube at Munderkingen, in Austria. Blocks of this kind have shown the remarkable resistance of 187 tons per sq. ft. in 7 days, 235 tons in 28 days, and 308 tons in 5 months.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Bridges.

31937. Notes on Rivet Holes and Sheared Edges in Steel, with Editorial (R'y Rev–May 18.) 2500 w.

31958.—$1 50. The Bridge Over the Tennessee River at Johnsonville, Tennessee. Ill. Hunter McDonald, with Discussion (Am Soc Civ Eng–March.) 6300 w.

31985. The Pivot Pier of the Third Avenue Bridge Over the Harlem. Ill. (R R Gaz–May 24.) 1100 w.

31992. Brooklyn Bridge Terminal Station. Ill. (St R'y Gaz–May 18.) 1000 w.

32307. Painting Iron Railway Bridges. Walter G. Berg (Eng News–June 6.) 8500 w.

Canals, Rivers and Harbors.

*31656. The Utilization of the Severn. Editorial (*Eng*–May 3.) 2900 w.

31704. Proposed Canal from the St. Lawrence to the Hudson. Ill. (Can Eng–May.) 1200 w.

*31746. The Beginning of the End. Editorial on the Manchester Ship Canal (*R'y Times*–May 4.) 600 w.

*31914. The Chicago-Sanitary District Canal—Description of the Work and the Methods of Construction on the Brighton Division. Ill. Alex E. Kastl (Jour Asso Eng Soc–April.) 5400 w.

*31951. River Improvement Works. Charles David Marx (Chau–June.) 5800 w.

*32037. The Baltic Canal. Anon. (*Ill Car and Build*–May 17.) 1000 w.

32063. Chicago's Great Canal (Fire and Water–May 25.) 1100 w.

†32221. The Nicaragua Canal. G. W. Sherwood (Jour Fr Inst–June.) 5000 w.

32288. The New European Ship Canals (Ir Age–June 6.) 1300 w.

*32334. The North-East Sea Canal (*Engng*–May 31.) 5000 w.

Hydraulics.

*31649. Failure of the Bouzey Dam. Ill. (*Engng*–May 3.) 1000 w.

*31651. Air Vessels for Rising Mains. Ill. Bernhard A. Smith (*Engng*–May 3.) 1800 w.

Irrigation.

31807. Irrigation by Wind. From La. Planter (Sci Am–May 18.) 1300 w.

*32124. The Future of the Great West. E. V. Smalley (Forum–June.) 4000 w.

*32352. Masonry in Tropical Irrigation Work. - Editorial (*Eng*–May 31.) 1300 w.

Miscellany.

31645. Locked Tents for Engineers and Surveyors. Ill. Patent of J. J. Rinn (Eng News–May 9.) 450 w.

31811. The Collapse of St. Catherine's Tunnel. Ill. (Sci Am Sup–May 18.) 600 w.

31831. Standard Connections for Rolled Beams. Ill. Henry S. Richard (Eng News–May 16.) 1200 w.

31970. The Comparative Adhesive and Cohesive Strength of Cement. Ill. Louis J. Affelder and Robert C. Brown (Eng News–May 23.) 900 w.

31975. Manufacture of Rock Wall Plaster. Ill. (Sci Am Sup–May 25.) 750 w.

31986. A Graphical Method of Studying Questions of Haul of Earthwork—The Mass Diagram. Ill. C. Frank Allen (R R Gaz–May 24.) 1000 w.

*32201. A Rapid Method of Approximation to Earthwork Quantities. A. H. Shield (*Eng*–May 24.) 300 w.

*32235. Water Jet Pile-Driving. Ill. James F. Hobart (Am Eng & R R Jour–June.) 1500 w.

32305. An Experimental Study of Field Methods Which Will Insure Stadia Measurements of Greatly Increased Accuracy. Ill. Leonard Sewal Smith (Eng News–June 6.) 4200 w.

*32340. The Royal Indian Engineering College, Cooper's Hill. Editorial (*Engng*–May 31.) 2000 w.

Serials.

28498. Thames Bridges. Ill. (*Engng*–Began Jan. 4—13 parts to date—30 cts. each).

31702. Cement Testing. Cecil B. Smith (Can Eng–Began May—1 part to date—15 cts).

31759. Notes on Reservoirs. C. B. Target (*Ind Engng*–Began April 13—2 parts to date—45 cts. each).

31829. The Chicago Main Drainage Channel. Ill. (Eng News–Began May 16—3 parts to date—15 cts. each).

31871. Glasgow Harbor Tunnel (*Engng*–Began May 10—2 parts to date—30 cts. each).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Ventilation in New York.

In *Heating and Ventilation* for May Mr. Fred P. Smith repeats an allegation which he made in the February number of the same publication,—to wit, that the methods of ventilation employed in New York "are crude, and the results below those secured in other localities." This allegation certainly challenged proof to the contrary, but Mr. Smith says that up to date none has been received, though his statements have been denied :

"Among the buildings I spoke of were two of special importance, buildings representative of the best it was believed money could purchase,—namely, the Metropolitan Opera House and Carnegie Music Hall. Of the first named I stated—without other evidence, I must admit, than that of breathing the air within the building during the performance—that 'the ventilation was less than required by law in Massachusetts for a six-room school,' and that 'for filthiness the air could not be beaten in the tenement districts.'

"To be sure, these are strong statements ; they ought not to be true statements ; but they were when made, and they are now. The first apparent result of the article was to rouse the well-known engineer who planned the original system to a sense of personal injury and a demand for retraction, this being followed by an examination on his part, showing how his work had been destroyed and his plans rendered well-nigh useless. Of course he, being an engineer of the right class, quickly receded from his demand. . . The building was erected in 1882-3, and in it was a system of heating and ventilation designed, and, I think, installed, by Mr. Frederic Tudor; There was then provided a fan, said to be capable of delivering 70,000 cu. ft. of air per minute, and the entire plant showed evidence of most careful attention to every detail ; there were numerous inlet openings, including some three hundred beneath the orchestra chairs. There were also large registers, or grilles, which allowed air to flow out to the attic and thence, through louvres, to the atmosphere. Much of the work then done, or, rather, of the system then planned, would now be considered crude, but ten years ago was in line with the best thought. If the original system were the present one, my criticism would have to be modified somewhat, for it would about fill one-half the Massachusetts measure, or give a supply of about 15 cu. ft. per minute instead of 30 cu. ft. per person."

Mr. Konrad Meier, one of Mr. Smith's critics, is in error, "for that system is not now in the building, and no substitute has been provided." Mr. Smith says further that "at the very time Konrad Meier was so sure I was wrong in my criticism, the Opera-House directors were holding meetings and receiving proposals for correcting the defects, or at least affording some relief."

When, after the fire that destroyed the original building, the present building was erected, "the ventilation was done in just about the average fashion of the New York talent, which means that it was not cared for at all." Mr. Smith then computes how much air at the maximum can be delivered into the auditorium, even at the questionable velocity of 12 ft. per second, and finds it to be only 15,000 ft. per minute, or about one-fourth the amount stated by Mr. Meier. Besides, there is no exhaust system equal to the supply, as the Massachusetts law requires. The basement is also used as a plenum chamber, which Mr. Smith regards as a serious fault. His argument upon this point deserves considereration, since the ventilation of a great many buildings comprises this feature. "Were it [the basement] used to exhaust vitiated air from above, then it could be put to its natural uses without hindrance ; all the odors complained of would be removed with the foul air, and much better results would be secured."

"I wish to assert very positively that the use of the basement for a plenum supply room, common as it is, endorsed and used though it is by eminent engineers, is wrong in principle, as well as very difficult and expensive in practice. The turning of theater floors into pepper-box affairs, with a lot of holes through chair legs or covered with mushroom caps, is as far from right as one can get. I must, in fairness, state that, when the fan has been in operation for 15 minutes, the air in the basement is perfectly sweet and wholesome, all the odors and filth having been blown into the opera house for the benefit of the audience."

"Authorities agree pretty well that, when the air is so vitiated by breathing as to show, on analysis, over ten parts carbon dioxid in ten thousand parts, it becomes a poison, harmful to the system. The exhalations from the lungs of four thousand five hundred persons render 135,000 cu. ft. of air impure to a harmful extent every minute. When ventilation is so deficient as in the Metropolitan Opera House, the air will become vitiated in a half hour. At the end of an hour it is bad, and begins to cause headache and drowsiness. At the end of two hours it reaches a condition of positive disgusting impurity, and before the end of the last act it is literally true that it cannot be beaten for filthiness in the tenement districts. It is with a gasp of relief that the carriages are sought and fresh air is found once more."

In conclusion it is alleged that "the perforation of floors with finely-divided inlets for fresh air is bad engineering, not only from the practical, but the theoretical, view. The space beneath the floors should be used for the foul-air exhaust rather than fresh-air supply. The withdrawal of air from near, or at, the ceilings removes the fresh, rather than the foul, air more than three-fourths of the time the rooms are used. Of Carnegie Music Hall I made no criticism except 'insufficient supply,' but commended the system. The engineer who planned it stands at the head of the profession, and only good work could be expected from him. Still he would make great improvements in the methods there employed were he to plan it after four years' study, which have elapsed since its completion."

Hospital Ventilation.

An example of cooling air for hospital ventilation by reversing the function of heating coils is described in the *American Architect* (May 4), in a paper reprinted from the *Proceedings of the American Academy of Arts and Sciences*. Dr. Morill Wyman gives an account of the experiment, which was begun in the spring of 1893. The coils first used were the hot-water heating coils used during the winter for heating air before admission to the wards. Water from 57° to 58° F. was available for cooling at the time the experiment was begun.

"On the first of May, 1893, all windows and openings in the air-chamber were carefully closed, and the water from the main let on. At 3 P. M. the external thermometer was at 84° F.; there was no wind, and the patients were suffering from the heat. The temperature of the air-chamber was 67° F.; the water as it entered the cooling boxes, 57-58°. The electric fan, 36 in. in diameter, driving the air into the air-chamber, was put in motion, making five hundred revolutions with an air-moving power of 10,200 cu. ft. a minute. At 4 P. M., the air entering the ward at the registers was at 71° F. During this hour 400,000 cu. ft. of air, as measured by a Cassella's air-meter, were thrown into the ward through the ten registers: a quantity sufficient to fill the ward of 21,000 cu. ft. twenty times an hour,—once in 3 minutes.

"The result was satisfactory; the comfort of the patients was manifestly improved. But it must be observed that the cooling-surfaces were, first, the ten cooling-boxes, of 30 sq. ft. each, at 57-58° F., and, secondly, the floor and the walls of the air-chamber, the two together amounting to about 3300 sq. ft. The temperature of these walls could not well be determined; but, as they had not been exposed to much increase of heat since the winter, they may be assumed to have been about that of the water-supply,—then 58° (in winter it is about 50°). At the outset, then, we had the air-chamber full of cool air and a cooling surface of about 3000 ft., along which the air, driven by the fan, was diffused before it entered the ward. The cooling power of the boxes may be assumed to be about one-tenth that of the walls." Subsequently, during the summer months, the temperature of the water rising, and the quantity needed entailing too much expense, the use of the coils for cooling was abandoned, but the same amount of ventilation was maintained by forcing the air into the ward by the same route, and the comfort thus afforded to patients was "immediate and decided." This result is attributed correctly to the increase of evaporation from the skin caused by the large volume of air circulated,—400,000 ft., per hour for sixteen patients,—"and yet, while this large quantity was passing through the ward, it was only known, except at the registers, by the accompanying sense of freshness and pleasant coolness. It was never felt as a draught." Without going further into the details of these experiments, we may say that the results led Dr. Wyman to the conclusions: "first, that fresh air directly from the open, in the quantity and manner there applied, can be made to give great comfort to the sick during the heats of summer; and, secondly, that previous cooling of the air so supplied is difficult and practically useless. To this may be added—what is of much importance to charity hospitals—that the method here adopted is the least expensive of the cooling processes hitherto made generally known."

The coils were only a little more than one-eighth the capacity they ought to have been to reduce 400,000 cu. ft., of air from 90° F. to 70° F. With cooling water at say 65° F., and with water at 70° F., the surface would have needed to be infinitely increased to effect such a result. If water could be obtained at about 54° the season through, as is sometimes, though rarely, the case with water from artesian wells, coils could be used with sufficient effect to cool a ward of this size, containing sixteen patients, and materially lower the temperature below the outside temperature; but to cool such a volume as was attempted in this case, even with water of this temperature, would require some six or seven times the cooling surface used in the experiment. Of course, the cooling in this attempt was "difficult and practically useless," as stated by Dr. Wyman. It does not seem possible that the cooling of air by bringing it into contact with surfaces cooled by evaporation of water was unknown to the hospital authorities, or that they did not know that the use of ice to cool water circulated through the coils would have been cheaper than the use of such a large volume of water taken from the city mains. Besides this, more efficient cooling would have lessened very much the volume of air needed to afford comfort to patients, and thus have reduced the cost of current for the fan. The use of ice would have entailed only a very moderate cost after the installment of a cheap apparatus for applying it.

Prehistoric Sanitation.

ARCHÆOLOGICAL research every day reveals the fact that modern progress, upon which we justly congratulate ourselves, had its prototype in past ages. The interest of a *conversazione* at Manchester, England, was much heightened (*British Architect*, April 26) by an address of Professor Boyd Dawkins, in which he sketched the progress made in sanitation by ancient people, the evidences of which are not written in books, but found only in the relics of the past. The beginnings were traced back even to the paleolithic age. The paleolithic man "had a fixed habitation," and he "invariably chose dry areas as areas of habitation. In the neolithic man we had the first evidence of a public, for they lived as a community. But even this people had nothing of the nature of sanitary knowledge. They left their refuse in their habitations, and they were ignorant of water-supply. With regard to their habitations, however, they presented us with several sanitary hints. They always selected those spots where there was natural drainage; and, with regard to ventilation, they had perhaps too much of it."

At the close of the bronze age, with the acquisition of iron, and, naturally, with the use of this material for implements, there were important developments in sanitary appliances. In certain camps which have been explored by General Pitt Rivers, particularly in one near Lewes, there has been found the most elaborate system of refuse-heaps. There were, however, in this age no evidences of any artificial water-supply. But neither in the neolithic, the bronze, or the pre-historic iron age were there any interments allowed within the area of habitation; and in that particular we can look back as far as those times for an example of a reform which is needed in some parts of the country. Evidence that in the bronze age cremation was the rule has been found in the limestone ranges of Derbyshire, and on the undulating surface of the chalk downs of Wiltshire.

Prof. Dawkins even went so far as to intimate that modern sanitary conferences might learn something from the ancient Romans. In the first place, Roman buildings were all more or less rectangular, and it is important to bear in mind that there was no jerry-building in those times. Their mortar was laid on hot, and not allowed to get rotten first, as is the case with us, and their cementing material was so strong and durable that it remains to-day, while a great many of the stones it cemented have disappeared into dust. Their water-supply was admirable. "Then, in the matter of drainage, they had a most perfect system of breaking the continuity of the drain inside and outside the house." The Roman excavations at Silchester show a most elaborate and perfect system of arterial drainage; and something like 1700 years ago, in the south of England, they were sufficiently advanced in sanitary matters to do very much the same sort of thing that Manchester is now attempting to do in sending her sewage by a system of arterial drains down to the lower waters of the Mersey. Their water-supply was exceedingly well organized, and, whenever they could bring a supply through the city or a villa, they did so. They sank wells sometimes to the depth of 100 ft., and they were well acquainted with the artificial methods of obtaining water. Their method of heating their dwellings was the most perfect that could be devised, consisting of a heating chamber in the basement from which a vast number of flues radiated through the dwelling.

Heating in Engineering Hall, University of Illinois.

THE arrangement of indirect radiators in the heating plant of this building is believed by Prof. L. P. Beckrenridge, chair of mechanical engineering, to be new. A description of it is given by him in *The Technograph*, published by the engineering societies of the university. Results of a series of tests of efficiency of the radiator surface are also given in tabulated form. A description of tests of temperatures in various parts of the building, and of the changes of position that were decided upon as the result of these tests, is also comprised in the paper, which is a good study in designing and constructing heating plants.

The system is what would be generally styled partly direct and partly direct-indirect. But, with reference to the piping, what is known as the Mills overhead system has been employed. The number of square feet of radiating surface is: direct (including pipes), 7559; indirect, 3159; or a total of 10,642 sq. ft.; and the ratio of heating surface to cubic feet of space heated is 1 to 77.

"The steam which is delivered into the sub-basement of the building at about 40 lbs. pressure is passed through an 8-in. Davis reducing pressure valve, and the pressure reduced to 1, 2, 3, 4, or 5 lbs., as the external temperature demands. For 3 weeks of this winter (1894-5) the temperature was down to zero nearly every night, and, on the occasion of one of the tests, was 22° below. During the severe weather the building was easily warmed with 5 lbs. of steam. With the temperature between 10° and 32°, above 3 lbs. is sufficient to warm the building, while for warmer weather 1 to 1.5 is all that is required.

"The steam, after passing the reducing valve, is carried through an 8 in. main to the attic of the building, where it divides into three equal branches 4.5 in. in diameter, and is thus distributed to the three wings of the building. The overhead mains in the attic are covered with asbestos fireproof covering. From the mains run the smaller mains to the sides of the building, and then drop to the sub-basement in one straight run. From these drop-pipes connections are taken, one to each radiator. Liberal provision is made for expansion of all pipes and connections.

"Nearly all the direct radiators are connected to the drop-pipes by a tee in the pipe near the ceiling of the room below; while the indirects are connected mostly by tees in the pipe at the floor-line of the room in which the radiators are placed.

"The indirect radiators are in all cases placed under the windows, and in a recess left for them in the brickwork. The air-supply comes through openings in the cast-iron plate, which forms the lintel of the window below, passing up to the radiator through a space left for it in the wall. Air is induced to flow through those radiators by ventilating shafts distributed throughout the building.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Heating and Ventilation.

†31491. Test of a Heating System. L. P. Breckenridge (Tech–No. 9.) 2000 w.

31700. The Hogan Vertical Water Tube Boiler.—Erected at the State Homœopathic Hospital for the Insane, Middletown, N. Y. Ill. (Am Mfr & Ir Wrld–May 10.) 600 w.

31838. Theoretical Velocity in Circulating Pipes.—Hot Water Heating. Ill. R. C. Carpenter (Met Worker–May 18.) 1200 w.

31844. Heating of the Hotel Stafford, Baltimore. Ill. (Eng Rec–May 18.) 1800 w.

*31860. Electrical Heating. D. H. Dowsing (*Elec Rev*–May 10.) 1400 w.

*31913. Defective Chimney Flues. John Millar (Dom Eng–May.) 1500 w.

31925. Heating and Ventilation of the Pennsylvania Railroad Station at Philadelphia. Ill. (Heat & Ven–May.) 1200 w.

31926. Ventilation in New York City. Fred P. Smith (Heat & Ven–May.) 2500 w.

31927. Loss of Efficiency in Direct Radiators Due to Massing of Surface. Ill. R. C. Carpenter (Heat & Ven–May.) 1000 w.

31993. Furnace Heating With a Fan. Ill. (Met Worker–May 25.) 1600 w.

*32055. The Ventilation of Hospitals and the Treatment of Infected Air. Abstract from the Lancet (*San Rec*–May 17.) 1800 w.

32080. A Church Hot Water Heating and Ventilating System.—St. George's Episcopal Church, Flushing, N. Y. Ill. (Mas St Fit–May.) 700 w.

32166. Heating a Conservatory at Northhampton, Mass. Ill. (Eng Rec–June 1.) 900 w.

32167. School Ventilation. Samuel A. Heins (Met Work–June 1.) 1000 w.

32170. Heating and Lighting of a Model School Building. Ill. C. B. J. Snyder (Arch & Build–June 1.) 1300 w.

32245. A Dwelling-House from a Sanitary Point of View. Isaac Young (*San Rec*–Began May 24—2 parts to date—30 cts. each).

32171. Heating and Ventilation of Churches. F. E. Kidder (Arch & Build–June 1.) 3800 w.

32330. Single-Pipe Hot Water Heating. Ill. William Beall (San Plumb–June 1.) 2500 w.

Landscape Gardening.

*32034. "Treillage." Ill. John Belcher, with Discussion (*Builder*–May 18.) 5000 w.

32104. The Debt of America to A. J. Downing. Editorial (Gar & For–May 29.) 1600 w.

32116. The Standard of Taste for Parks (Soc Ec–June.) 2500 w.

Plumbing and Gas Fitting.

31924. Bending Wrought Iron Pipe. Ill. William Beall (San Plumb–May 15.) 2000 w.

*32054. Qualifications Required by Plumbers to Fit Them as Sanitary Inspectors. J. Radcliffe (*San Rec*–May 17.) 3300 w.

Miscellany.

*31626. Pre-Historic Sanitation (Abstract.) Boyd Dawkins (*Brit Arch*–April 26.) 800 w.

*31665. The Modern Kitchen (*Plumb & Dec*–May 1.) 600 w.

*32039. A Healthy Home. Anon. (*Ill Car & Build*–May 17.) 1500 w.

Serials.

26907. Hot Water Heating and Fitting. Ill. J. L. Saunders (Heat & Ven–Began Nov., 1894—6 parts to date—15 cts. each).

29334. Technical Subjects That Plumbers Should Know. Ill. F. Dye (*Plumb & Dec*–Began Feb.—4 parts to date—30 cts. each).

30985. The Heating of Dwelling Rooms. Walther Hempel (Am Man & Ir Wld–Began April 12—2 parts to date—15 cts. each).

31223. On Bathing and Different Forms of Baths. William Paul Gerhard (Arch & Build–Began April 27—Ended May 11—3 parts—15 cts. each).

31229. Plumbing in the Constable Building. Ill. (Eng Rec–Began April 27—3 parts to date 15 cts. each).

We supply copies of these articles. See introductory.

ELECTRICITY

Modern Central-Station Practice.

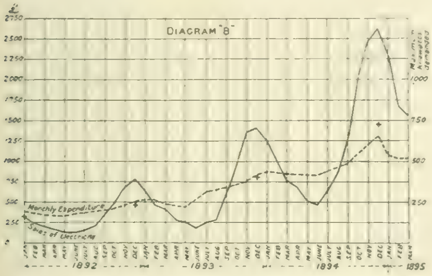
In the May number of the *Sibley Journal of Engineering* is given in full a lecture delivered by S. Dana Greene before the students of Sibley College, containing an up-to-date *résumé* of the state of the art of central-station engineering. The author states that there are now 2500 central stations in the United States, representing aggregate assets of over $300,000,000. The design of the original installation, upon which the fixed charges depend, has also a direct and permanent influence upon operating expenses, but, the money having been spent, existing appliances must be utilized as best they may be under the circumstances. On the other hand, both the gross earnings and operating expenses are largely dependent upon management, and it is here that the well-instructed mind finds a field of unlimited extent and of attractive possibilities. The country is filled with horrible examples of how central stations should not be erected. The building should be of brick and steel, one story in height, the boilers separated from the dynamo room by a heavy fire-wall. The tendency of all new plants is towards high steam-pressure, and the type of work approaches that of standard marine engineering. A complete system of automatic distribution of oil is recommended. Compressed air is a convenient means of cleaning dynamos. The best practice locates the switchboard and regulating apparatus in a gallery at one end of the dynamo room, commanding a clear view of the whole place. Belting and countershafting are extravagant in space and inefficient in operation ; hence the modern tendency is towards vertical compound engines of the marine type, with a generator armature directly coupled to each end of the shaft. This plan was conceived and carried out 15 years ago by Edison in his first central station in New York city, but his ideas were ahead of his time, simply because manufacturers had not then the experience and skill to carry them to their logical conclusion. In determining the dimensions of the generating units, grea caution should be exercised ; due regard must be given to maximum load, average load, and change of load during 24 hours For economical reasons direct-connected units should not be operated at less than 60 to 70 per cent. load ; yet they should be of equal size, so far as the above conditions admit, in order to secure interchangeability of parts and economy in attendance. The practice of using different classes of generators for incandescent-lighting, arc-lighting, and power-service is disappearing. All these services are now supplied from common mains by direct-current low-tension generators, and recen improvements in multiphase, low-frequency alternating generators, arc-lamps and induction motors make it possible to effect the same results with alternating currents. The largest alternating station in the country (St. Louis, 150,000 16-c. p lamps equivalent connected load) is now being remodeled to this end. All generators of like type, whether direct or alternating, are now operated in multiple, feeding into common bus bars, from which service feeders are taken off as required.

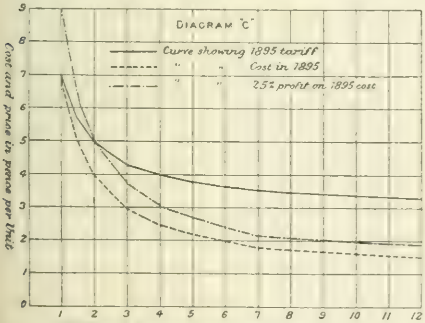
Devices are in use for raising or lowering pressure upon individual sets of feeders, as variations in length or load may require, the bus-bars being maintained at a constant pressure midway between the extremes required by the several feeders In some cases a combined direct and alternating plant has been found economical (*vide* account of Brighton plant, in another note). Storage-battery plants are successfully used abroad, but in this country, owing to the greater proportion of day-load from motor-service, etc., the cases where they can be economically used have thus far been few. Conductors within the stations are mounted wholly on porcelain supports. Many of the large stations in this country do not contain a pound of combustible material of any kind [except coal]. In laying out a sysem of distribution, the loss of voltage should be confined practically to the feeders, which can be done by careful compuation; the three-wire system of mains effects a large saving of copper, and is always to be preferred. In some of the direct-current low-tension plants in our arge cities, the loss in the entire distribution system is less than 20 per cent., and the depreciation less than 2 per cent. per annum. For economical reasons the area of low-tension service must be confined to an area within about 1 mile of the station. Hence the expense of erecting so many stations is enormous (there are five in New York city), and may become prohibitive. The single-phase alternating system with two-wire 50-volt secondaries, though in extensive use in this country, is limited in the character of its service, and uneconomical in its results. The recent development of the phasal modifications of this system have, however, enormously increased its possibilities of usefulness, so that now it not only presents most of the advantages of the direct current systems, but is capable of economically covering a far greater area from a given station. The characteristic features of such a system are: (1) large transformers, banked at sub stations; feeders at 2000 volts or more carried to these sub-stations, and the consumers served thence by three-wire secondary mains of 220 volts, the mains from different sub-stations being inter-connected; (2) generators coupled in multiple arc; (3) frequency reduced to about 60 cycles per second, reducing loss from impedance in conductors and giving better motor service; (4) high-efficiency incandescent lamps, arcs, and induction motors supplied from secondary mains; (5) pressure on secondary mains constant within 2 per cent., and entire loss on distributing system not exceeding 10 per cent. Many stations might remodel their existing plants in accordance with this practice with the utmost advantage. The public is becoming more exacting as to the character of its electric service, and meanwhile the competition of gas and other illuminants is steadily forcing down the price of current. These conditions must be met; hence it is poor economy to patch up an old plant with its inherently high operating-expenses and defective service. Remodel, but do not patch. In recent practice fuses are omitted in the distributing mains and at junction-points between feeders and mains.

The kilowatt is becoming the universal unit of electric energy, both for charging customers and computing the cost of production. Every consumer should have a watt-meter to be read once a month, and the central-station a recording watt-meter to measure the total output; the loss on the lines can thus be checked by the difference in readings. The most profitable customers are those who use the current for the greatest number of hours; unfortunately the great majority consume current for a few hours only, and then all use it at the same time; consequently the output varies widely during the 24 hours. The "load-factor" is the ratio between average and maximum load, and the central-station manager seeks to make this as high as possible by finding uses for current outside of lighting hours. The usual method of charging 12 to 20 cts. per kilowatt-hour takes no account of the customer's load-factor; for example, one may use 2 k. w. 24 hours per day for 30 days, and another 24 k. w. 2 hours per day for 30 days; each would be charged for 144 k. w. hours; the first customer provides a steady and profitable load for the station; the second an unsteady and undesirable load; in equity the first consumer ought to have his current at a lower price. In many stations abroad the discount on the customer's bills is based largely on his load-factor. The load-factor of many European stations is only 15 per cent.; it is 33 per cent. in London, while in this country it runs as high as 40 and even 50 per cent. in the better class of stations. This great difference is principally due to the more extended use of motors in this country. During two years past 30,000 arc-lamps have been installed on incandescent circuits in this country. There is a growing demand for current for electro-metallurgy and medical and dental work, as well as for heating and cooking. All such demands tend to diversify the load and increase the load-factor, and should be encouraged in every way. If the first duty of a manager is to increase his gross revenue and his load-factor, his second duty is to reduce his operating expenses. A record of the station load should be made at least hourly; every pound of coal, oil, or waste, should be accounted for. Operating expenses should be carefully analyzed and tabulated. The principal items are: fuel, oil, and waste; water; labor; renewal supplies; repairs to plant; repairs to lines; insurance; salaries and office-expenses. At the end of the month each separate item should be footed up and averaged for each kilowatt-hour output. The operating expenses of a well-managed plant (except in small towns) should not exceed 50 per cent. of gross receipts; in some large stations it runs as low as 33 per cent. Apparatus and station should be kept scrupulously clean; nothing decreases efficiency and increases repairs more effectually than dirt. A regular system of inspection and reports is necessary, and, when anything is out of order, it should be attended to at once. If a local company is to be successful and keep pace with the growth of business, the following rules must be kept in mind: Let local conditions be thoroughly studied and digested; then select the apparatus and methods of distribution best suited for these conditions, and make the plant as complete and economical as the state of the art admits; make wise provision for future increase; create the greatest possible demand for electric power; make the charges reasonable, and with due reference to the load-factor of the customer; analyze the monthly operating expenses, and effect a saving wherever possible; keep everything clean and in thorough repair; and, finally, do not pay dividends unless they have been earned, after paying all charges and allowing for depreciation and reserve fund. This is one of the most suggestive and valuable essays upon the subject of which it treats that in extensive reading has ever come under our notice.

Central-Station Experiences.

ONE of the most profitable papers which has found its way into print for some time is, in our opinion, that read by Arthur Wright before the Municipal and County Engineers and published in the *Electrical Engineer* (London) of May 10. Mr. Wright states that Brighton was the first town in England in which a central station was established; the first in which current was sold by meter; the first to adopt a differential rate of charge based on actual cost of supplying each consumer; and the first to make simultaneous and conjoint use of the direct and alternating systems of distribution. It also enjoys the perhaps unique distinction of having suffered from four different systems of distribution within 10 years. Mr. Wright showed from the board of trade returns of 1894 that the actual cost of supplying electricity from the works of the Brighton corporation was less than from any other central station in Great Britain, and that, taking all the towns of over 50,000 inhabitants, the sale of electricity per capita was greater in Brighton than in any other place. The figures of cost given range from 2.3 pence in Brighton to 3.72 pence in London. It was pointed out that the cost of continuing to produce electricity, after everything has been put in readiness, constitutes an extremely small portion of the total expenditure. Diagram B shows how very slightly the total monthly cost of running the station is affected by the actual quantity of current sent out. The crosses indicate the time of maximum demand each year. It is apparent that the total monthly expenditure depends much more largely on the maximum rate at which current has to be supplied in any one year than on the actual quantity that has been supplied. The scale of charges has been devised in accordance with these facts. The ordinary rate of 7d. (14 cents per k. w. h.) is reduced to 3d. (6 cents) whenever the due proportion of cost of having to be ready to supply any particular individual has been met by revenue derived from his previous consumption in the same half-year, at the first-named rate. Thus those who use current regularly 4 hours per day are supplied at 4d. per unit. Diagram C shows how rapidly the cost of supplying electricity diminishes as the length of time the demand is in force increases each day. Although at Brighton station coal costs over 20s. ($5) per ton, yet the author says that, owing to the long hours of consumption,— nearly 11 hours per day,—current can be supplied for street-lighting at a profit at 2d. per unit (4 cents per k. w. h.). No other kind of artificial illumination can successfully compete with electricity at this figure. In view of the above considerations, Mr. Wright thinks that too much attention has been devoted by central-station engineers to the matter of the reduction of running cost, to the neglect of the more important question of the reduction of the much greater standing costs involved in supplying electricity. He gives great credit to Mr. Ward Leonard, the American engineer, who pointed out as long ago as 1892 that the obvious corollary from the well-recognized fact of the low-tension system being the most efficient at light loads and the high-tension at heavy loads must be that some combination of the two ought to give the maximum efficiency; and it was clear that, providing the details could be satisfactorily worked out, as they now have been, it must necessarily be more economical to run only the high-tension alternating system when the demand is heavy, and at all other times to supply the residential districts from the low-tension continuous-current system, and not continue the use of the alternating supply when the only reason for its use has ceased to exist,—*viz.*, big loads at long distances. In Brighton, transformer chambers are placed at convenient points, from which extend low-tension distributing mains for supplying residences at times of heavy load, and these mains are switched on to the low-tension mains at certain convenient points during times of light load. Meters are employed which register equally well either direct or alternating currents. As the period of light load lasts on the average ten times as long as the period of heavy load, it is clearly not advisable to supply through transformers districts which can be supplied with much less loss through the ordinary low-tension distributing mains. If the proof of the pudding is in the eating, we think that Mr. Wright has made out his case. The lowest cost of production coupled with the largest consumption per capita of any town in the kingdom indicate pretty certainly that his 10 years of experience in central-station lighting have taught him some valuable lessons, by which many others might well profit.





Electricity of Elevated Railways.

THE first elevated railway in the United States, of permanent construction, operated entirely by electricity is that of the Metropolitan Company of Chicago, a somewhat full description of which appears in the *Electrical Engineer* (May 15). This line is unique, not only in that it is operated by electricity, but in that it is built upon its own purchased right-of-way, no other franchise having been sought and obtained from the municipal authorities than that of crossing the public streets at an elevation. Title to the necessary land has been obtained at a cost of some $6,000,000, and most of the purchases are now held by the company in fee-simple. All buildings on the location worth preserving were carefully removed to other locations, the rest being demolished. One of the buildings successfully removed was the Normandie flats,—an immense stone structure. Generally the line passes through the centre of the blocks. For a distance of two miles westward from its principal terminus in the heart of the business district of the city, four tracks have been provided, beyond which four two-track lines spread out fan-like in different directions, all of the latter, with the exception of the southwestern line, being now completed. Two of the four trunk-line tracks will be used for express service. The power-station is 300 ft. by 90, and has a present capacity of 6000 h. p. There are four engines of the inverted compound direct-acting Corliss type,—two of 2000 h. p. and two of 1000 h. p.,—and 12 boilers of 300 h. p. each, fitted with mechanical stokers and smoke-consuming devices. A safety-valve in the main steam-pipe is arranged to automatically close the instant the speed exceeds a determined rate, as a safeguard against fly-wheel accidents. The entire electrical equipment—generators, motors, and accessories—was furnished by the General Electric Company. The present outfit comprises two 1,500-k. w. generators and two 800-k. w. generators, which are designed to withstand a temporary overload of 60 per cent. The generators are placed between the high and low-pressure sides of the engines, and are thus enclosed by the engine frames. The current is conducted from the station by heavy feeder-cables to a lateral third rail, which serves as a working conductor. This is outside of and above the service rails, and is bonded with copper strips. Each motor truck is equipped with a sliding contact-shoe which runs on the third rail, being flexibly suspended from an oaken beam projecting laterally from the truck-frame. The motors are of the single-reduction type, and are rated at 100 h. p. each, under normal conditions. The maximum speed capacity is between 30 and 40 miles per hour. The average speed on the suburban portion of the line, including stops, is about 13 miles per hour. The road commences operations with an equipment of fifty five motor cars and one hundred trail-cars.

Electrolytic Reduction of Aluminum.

THE *Western Electrician* (April 20) contains an interesting illustrated paper describing the electric plant of the Pittsburg Reduction Company, at Niagara Falls. The transformers are nearly in readiness to receive current from the power-house. The outfit comprises four rotary transformers of 500 h. p. each and eight stationary transformers of equivalent aggregate capacity. The cables from the power-house are four in number, and laid directly on the floor of the subway. The conductors in these cables are each 950,000 circular mils area of cross-section. The two-phase alternating current from the power-house is delivered at a pressure of 2000 volts, which is reduced to 115 volts by the stationary transformers, and then by means of the rotary transformers re-converted into a direct current of 160 volts, after which it is ready to be conducted to the electric furnaces in which the aluminum is smelted. The capacity of the apparatus is 10,000 amperes at 160 volts. The stationary transformers are cooled by means of an air-blast.

The Danger-Line in Electric Pressure.

IN reference to a case reported not long since, in which the operator of an electric mining machine was killed, as circumstances appeared to indicate, by an electric current of a potential of 280 volts,—but little more than half that which has usually been regarded as the outside danger-limit, —Mr. Richard Lamb, in a communication to the *Electrical Engineer* (May 8), says that too much publicity cannot be given to the fact that even so low a pressure as 110 volts may prove fatal, if applied to a bleeding sore and allowed to remain for a few minutes. With 280 volts applied under similar conditions the person would be killed almost instantly. The explanation which the writer offers is that the blood is so good a conductor that the current is transmitted through the arteries and veins directly to the heart. It is not improbable that some of the mysterious deaths which have been reported from what are ordinarily regarded as perfectly safe currents may be explainable in this way.

Interior Electric Wiring.

In the *Architect and Builder* (December–January) is an excellent paper on the above subject, read by Charles E. Burton before the Northwestern Electrical Association. Mr. Burton thinks it is very little to the credit of the electric-light companies, or the business of electric lighting, that the underwriters have been compelled to take the initiative steps towards the improvement of the electric business. If the standard of electric wiring has fallen so low as to require the rigid supervision and inspection now exercised by the underwriters, it is quite time that the electric companies sought to protect their own interests by guarding against the introduction of poor labor and poor material. Now that electrical engineering has assumed the dignity of a permanent profession, it should no longer require such surveillance by those who claim to have received injury from the failure of the electrical companies to conduct their business on a safe basis. We would think very poorly of a physician whose prescriptions required inspection before they could safely be used. The underwriters have learned by costly experience that electric-light companies as a rule are exceedingly negligent in the inspection of the interior wiring to which they attach their supplying conductors, and hence they insist that they themselves shall, by rigid inspection, discover and point out the hazards, and compel their correction. Mr. Burton thinks that the ideal system of wiring, from the point of view of greatest security and insulation, is exposed, heavily-insulated wire, supported upon non-combustible insulators. For concealed work he predicts the universal adoption of the iron-armored conduit, which, he thinks, meets every requirement of engineers as a permanent mechanical protection for interior wiring.

An Extensive Water-Power Project.

The Minnesota Canal Company, an organization of Chicago capitalists, is reported by the *Railroad Gazette* as having made surveys along the north shore of Lake Superior for a distance of 100 miles northeast of Duluth, Minn., with a view of utilizing the waters of the numerous small streams flowing from the high ground north of the lake, and conducting them through a canal 80 miles in length to a reservoir some 600 ft. above the water-front of that city. The plan is to distribute the water from this reservoir in pipes to furnish power for manufactories along the water-front, as well as to convert a considerable portion into electric power to be used for general purposes. It is computed that power can be furnished for not more than $10 per h. p. per year. The original plan was to utilize the water of the St. Louis river, which flows into the lake from the southwest, and has a rapid fall. The volume of water in this river was found upon investigation to be extremely variable, ranging between such wide extremes as 250 cu. ft. and 17,000 cu. ft. per second, rendering extensive provision for summer storage necessary. The north shore streams have been found to be much more constant in their flow. The company has secured the necessary legislation, and has instituted condemnation proceedings for acquiring the necessary rights of way for the whole length of the canal. It is estimated that the cost of the entire project will not exceed $4,000,000. It does not appear that any actual construction work has yet been done.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Lighting.

*31633. Interior Conduit and Interior Wiring. Charles E. Burton (Arch Build & Dec-Jan.) 2300 w.

*31662. Decorative Electric Lighting. Ill. (*Elec Rev*-May 3.) 4500 w.

†31670. Lighting Installations. H. A. Henderson (*Ind & East Eng*-April 6.) 2000 w.

We supply copies of these articles. See introductory.

*31693. Leicester Electric Light and Power Station. Ill. (*Elect'n*-May 3.) 2000 w.

31765. Scientific Fishing—Use of the Electric Light. From Chicago Tribune (Sta Eng-May.) 1500 w.

*31866. Points of Interest in the Development of Electricity Supply at Brighton. Arthur Wright (*Elec Eng*-May 10.) 2200 w.

*31955. Some Suggestions on Central Station Practices, with Special Reference to Developments during the past year. S. Dana Greene (Sib Jour Eng-May.) 6000 w.

*32040. The Recent Development of the Single-Acting, High-Speed Engine. Editorial in paper by Mark Robinson (*Elec Rev*-May 17.) 2800 w.

*32047. Cheltenham Electricity Works. Ill. (*Elec Eng*-May 17.) 6000 w.

32145. Non-Magnetic Arc Lamp. Ill. W. E. Irish (W Elec-June 1.) 700 w.

32292. A Combination Alternating and Direct Current Plant—Budapest, Hungary. Ill. (Elec Wld-June 8.) 3000 w.

30806. Alternate Current Motors. W. G. Rhodes (*Elec Rev*-Began March 29—2 parts to date—30 cts. each).

30872. Telephony. Ill. V. Wietlisbach (Elec Engng-Began April—2 parts to date—15 cts. each).

30938. Lighting and Electric Lighting as a Business. George White Fraser (Can Elec News-Began April—Ended May—2 parts—15 cts. each).

30939. Dynamo Design. E. B. Merrill (Can Elec News-Began April—2 parts to date—15 cts. each).

30973. Electric Mains in Paris. A. Monmerque (*Elec Eng*-Began April 25—3 parts to date—30 cts. each).

31284. Electric Lighting on Trains. Ill. R. W. Weekes (*Elec Eng*-Began April 19—2 parts to date—30 cts. each).

31344. Practical Telephony. Ill. James Bell (*Elec*-Began April 19—7 parts to date—30 cts. each).

31530. Alternating and Interrupted Electric Currents. Report of Lectures by George Forbes (*Elec Rev*-Began April 26—3 parts to date—30 cts. each).

31859. The Chemnitz Central Station. Ill. (*Elec Rev*-Began May 10—Ended May 17—2 parts—30 cts. each).

31865. On the Recent Development of the Single-Acting, High Speed Engine for Central Station Work. Mark Robinson (*Elec Eng*-Began May 10—Ended May 24—3 parts—30 cts. each).

31934. Accumulator Battery for Telegraphic Purposes. Directions for Installation and Maintenance. Ill. Harry Hofmeister (Elec Rev-Began May 22—Ended June 5—3 parts—15 cts. each).

32038. Nikola Tesla and His Work. Anon. (*Ill Car & Build*-Began May 17—2 parts to date—30 cts. each).

32164. The Shops of the Westinghouse Electric and Manufacturing Company. Ill. (Eng Rec-Began June 1—1 part to date—15 cts).

32246. Atmospheric Electricity. A. Schuster (*Elect'n*-Began May 24—Ended May 31—2 parts—30 cts. each).

32254. Recent Experiments on the Electric Discharge, by Lord Armstrong. Ill. (*Elec Rev*-Began May 24—Ended May 31—2 parts—30 cts. each).

*32360. Electric Lighting at Hong Kong. Ill. (*Elec Rev*-May 31.) 1600 w.

*32363. Cheltenham Electric Lighting. Ill. (*Elec Rev*-May 31.) 3000 w.

Power.

†31674. The Electrical Transmission of Power. William M'Whirter (*Ind & East Eng*-April 13.) 3500 w.

*31691. Electrical Plant at the Crewe Works. Ill. (*Elect'n*-May 3.) 1900 w.

*31858. An Interesting French Electric Lighting and Power Transmission Plant. Ill. (*Ind & Ir*-May 10.) 2400 w.

*31874. Electric Welding for Repairs. Editorial (*Engng*-May 10.) 1700 w.

31882. An Electric Mining Plant. J. J. Ormsbee (Tradesman-May 15.) 900 w.

31953. Coal Handling by Electricity. Ill. (Ir Age-May 23.) 800 w.

*32032. Rotary-Current and Alternating-Current Dynamos of the Allgemeine Elektricitats Gesellschaft. Ill. M. von Dolivo Dobrowolsky (*Elect'n*-May 17.) 1000 w.

32070. Hints upon Daily Work about a Dynamo Plant. Pliny Norcross (St R'y Elec News-May.) 3000 w.

32134. The Possibilities of Electrical Pumping Machinery. Charles A. Hague (Eng News-May 30.) 1000 w.

32146. Some Practical Hints in Dynamo Design. Ill. Gilbert Wilkes (W Elec-June 1.) 3800 w.

32326. Electric Driving of Tools in the Baldwin Locomotive Works, Philadelphia. Ill. Patrick Drolan (Am Mach-June 6.) 2000 w.

Telephony and Telegraphy.

31715. Electrolysis of Underground Cables of the Wisconsin Telephone Company in the City of Milwaukee. E. M. Dexter (Elec Engng-May.) 2200 w.

31720. Telephonic Communication between Light-Ships and Shore (Elec Age-May 11.) 1200 w.

31823. Plans of the Wisconsin Telephone Company (West Elec-May 18.) 1000 w.

31824. Annual Meeting of New England Telephone and Telegraph Company (West Elec-May 18.) 2200 w.

*31855. The Madagascar Cable (*Elect'n*-May 10.) 800 w.

31935. Berliner Patent Upheld (Elec Rev-May 22.) 2800 w.

32085. The Telegraph Service of Great Britain (R'y Rev-May 25.) 1000 w.

†32095. A Cable Post.—The Possibilities of tlantic Submarine Communication. J. Hen- iker Heaton (N Amer Rev–June.) 4000 w.

32127. The Mexican Government Tele- raph Service—The Zone System of Rates. ll. George Heli Guy (Elec Eng–May 29.) 800 w.

32159. Berliner Telephone Patents. Ill. Elec Wld–June 1.) 2500 w.

32168. Visual Sound-Writing by Word of Iouth. W. E. Irish (Elec Age–June 1.) 100 w.

32278. The Telephone Situation—Wondrous rowth of the Independent Companies (Elec- une 5.) 4500 w.

Miscellany.

31583. Non-Magnetic Electric Devices. Ill. V. E. Irish (Elec Eng–May 8.) 2500 w.

*31684. The Effects of Electric Currents in ron on Its Magnetism. J. Hopkinson (*Elec ng*–May 3.) 3200 w.

*31695. Variation of Internal Resistance of Voltaic Cell with Currents. Henry S. Car- art (*Elect'n*–May 3.) 800 w.

31716. Conductor Materials. Frederic A. . Perrine (Elec Engng–May.) 2500 w.

31717. Elements of Complex Quantities and ectors with Reference to Their Use in Alter- ating Current Work. F. J. Dommerque (Elec ngng–May.) 2000 w.

31801. The Quantity Upon Which a Knowl- dge of the Nature of Electricity and Magnetism epends. Reginald A. Fessenden (Elec Wrld- lay 18.) 1000 w.

31802. Experiments with Electric Waves. lfred G. Dell (Elec Wld–May 18.) 1000 w.

31803. Contribution to the Theory of emagnetization. Edwin J. Houston and A. . Kennelly (Elec Wrld–May 18.) 1300 w.

*31834. Is Vitality Electrical? (Self Culture- lay.) 2800 w.

*31854. Representation of Periodic Currents y Polar Diagrams. J. A. Fleming (*Elec'n*- lay 10.) 1200 w.

*31857. On the Electrification of Air. Ill. ord Kelvin (*Elect'n*–May 10.) 1800 w.

31941. Microscopical Research in the Elec- rostatic. Ill. George T. Hanchett (Elec Wld- lay 25.) 1400 w.

*32029. The Zickler Universal Electro Dy- amometer. Ill. (*Elect'n*–May 17.) 1800 w.

*32041. Cyanide of Potassium and Elec- icity. Emile Andreoli (*Elec Rev*–May 17.) 500 w.

32128. Electrical Thermal Devices. W. M. tine (Elec Eng–May 29.) 1500 w.

32160. On a Possible Law of Residual Mag- etism in Iron and Steel. Edwin J. Houston nd A. E. Kennelly (Elec Wld–June 1.) 600 w.

*32190. Uses of Accumulators. J. C. Iowell (*Elec Eng*–May 24.) 4500 w.

†32222. Lightning Arresters, and Why They ometimes Fail. Ill. Alexander Jay Wurts our Fr Inst–June.) 4200 w.

*32247. Graphical Methods of Finding Mean Square Values. Alexander Russell (*Elect'n*–May 24.) 500 w.

*32249. Variations of Electrical Pressure in London. A. A. C. Swinton (*Elect'n*–May 24.) 500 w.

32280. An Unpremeditated Execution. Herbert Laws Webb, in "Electric Power." (Elec Rev–June 5.) 5000 w.

32291. On the Causes Producing Phase Differences in Alternating Current Circuits. Edwin J. Houston and A. E. Kennelly (Elec Wld–June 8.) 1100 w.

32293. Self Induction and Capacity. E. B. Rosa (Elec Wld–June 8.) 3500 w.

32297. Electricity in the Bleaching of Textile Fibres. Louis J. Matos, in Textile Industries (Sci Am–June 8.) 2400 w.

32315.—75 cts. Studies on the Voltaic Cell. H. M. Goodwin (Tech Quar–Dec.) 11500 w.

*32362. Variation of Internal Resistance of a Voltaic Cell with Current. Henry S. Carhart, in the Physical Review (*Elec Rev*–May 31.) 700 w.

*32376. Resonance in Transformer Circuits. Frederick Bedell and Albert C. Crehore, in the Physical Review (*Elec Eng*–May 31.) 3000 w.

*32377. Present Range and Accuracy in the Measurement of Electrical Resistance. Herschel C. Parker, in Electric Power (*Elec Eng*–May 31.) 700 w.

*32381. A Contribution to the Theory of Demagnetization. Ill. Edwin J. Houston and A. E. Kennelly (*Elect'n*–May 31.) 1200 w.

Serials.

6515. Notes on Submarine Cable Work. Ill. H. D. Wilkinson (*Elect'n*–Began Sept. 2, 1892—15 parts to date—30 cts. each).

22059. Practical Notes on Dynamo Calculation. Alfred E. Wiener (Elec Wld–Began May 19, 1894—34 parts to date—15 cts. each).

23866. Electrodynamic Machinery. Ill. Edwin J. Houston and A. E. Kennelly (Elec Wld–Began July 21, 1894—37 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (Elec Age–Began Aug. 25, 1894—28 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (*Elec*–Began Oct. 5, 1894—35 parts to date—30 cts. each).

27371. The Electric Light. Henry Stooke (*Ill Car & Build*–Began Nov. 23, 1894—27 parts to date—30 cts. each).

27506. Suggestions in Preparing Specifications for the Electric Lighting of Buildings. Nelson W. Perry (Eng Rec–Began Dec. 8, 1894—4 parts to date—15 cts. each).

29158. The Construction and Use of Electrical Measuring Instruments. Charles H. Yeaman (*Elec*–Began Feb. 1—15 parts to date—30 cts. each).

INDUSTRIAL SOCIOLOGY

The Commercial Union of The States.

UNDER this title *The Railway Review* (May 11) printed a report of a witty and pithy address delivered by Mr. Chauncey M. Depew before the Detroit chamber of commerce May 2, 1895. There is in this address food for serious reflection, as well as much that is amusing. The speaker has a world-wide reputation for dressing strong intellectual meat in the most inviting form.

"Whatever political differences may divide the sections of our common country, there is an intelligent union of interest among its business men. There may be a clashing upon party lines between Michigan and Missouri, New York and Georgia, Pennsylvania and Alabama, Maine and California, but the chambers of commerce and the boards of trade of New York and San Francisco, of Portland, Me., of Philadelphia and Atlanta, of Detroit and New Orleans, of Savannah and Duluth, of Chicago and Charleston, consider the questions which affect the business and the commerce, the trade, and the agricultural and the manufacturing interests of our country upon the recognized principle of commercial prosperity and the immutable laws of trade. Thus it is that the commerce of the United States is the ever-strengthening bond of union of the commonwealths which constitute the republic. It is significant of the rapidity with which the American people escape the thraldom of prejudices, misrepresentation, and demagogues that we, who are interested in so large a part of the railway ownership and management of the United States, should be participants in this celebration with gentlemen who represent every industry of this great and thriving State. The time has come when the people of the United States, with but few exceptions, are recognizing the fact that the farm, the factory, the mine, the mill, and the railroad are inseparably and independently connected, and that the prosperity of any one of them benefits all, and an injury to any one of them is an injury to the rest."

Speaking of the change in the attitude of State legislatures toward railroads, which now for the most part is favorable, it was remarked that this assertion of "common sense over rabid sentiment" was first manifested in New England. New York, in 1888, "presented at the national Republican convention the president of its chief railway as the State's candidate for president of the United States . . . Well-meaning men used to come to my room as a matter of curiosity with an accident-ticket in one pocket and a prayer-book in the other. The one provided for their familes in case the evil one should whisk them off to the infernal regions, and the other presented the usual and time-honored method of exorcising the devil. My head was curiously examined to find the evidence of horns,—I mention horns, however, with considerable modesty, since the governor of the State of Illinois has recently declared that I do not know on which end of the anima horns grow. It is now, however, generally admitted that, whatever progressive position the railway may have once taken, it no longer asks anything except to be considered in the same light as other occupations and other properties. Its position can be accurately stated in the language of the mate of the whaling schooner when the surly captain had offered him, because o his success in capturing one of the monsters of the deep, promotion, honorable mention, and a share in the profits. Said the mate: "Capting, I don't want no promotion. I don't want no honorable mention. I don't want no share in the profits All I want is common civility, and that o the darndest commonest kind."

Of the present age Mr. Depew said tha "steam, electricity, and inventions have so accelerated the pace of progress, have so reduplicated the forces of industry and trade, that the individual has lost his place Capital combines in corporations, not onl where it is required in vast sums for railways and telegraphs, but in lumbering, mining, manufacturing, and store-keeping. Labor combines, both in separate industries and in general federation. The educator and the scientist discover that development is so rapid that they also must form associations if they would keep step with the truth. The unit upon which liberty formerly relied must now be a drilled and disciplined soldier assigned to his company, his regiment, his brigade, and his corps." Of all the forms of commercial association, chambers of commerce are the most beneficent. When a man steps from the realm of business to enter a political career, "the effort to spread himself all over this great country seems to so thin his gray matter as to make him incapable of bringing to the business of the nation the same common sense which made him succeed at home." As proof of this, the congress that has recently adjourned is cited. Mr. Depew, however, does not indicate whence our legislative bodies are to be better recruited, since he applied the same remark to professional men who fatuously engage in politics. The address concludes with a restatement of Mr. Depew's well-known views on the currency question, and some remarks upon the close relation of our educational systems and the material development of the country.

Cure for Slums.

THIS subject is discussed in *The Forum* for June by Mr. E. R. L. Gould, special agent of the United States department of labor. Drunkenness, criminality, and moral degradation, the "never-failing products of the slums," are typified by a "cancer," for which "there is no cure except the knife." There is no other "satisfactory way of dealing with irremediable insanitary premises than to tear them down." The paper therefore directs public attention toward the policy of expropriation, which "is the best militant weapon that a board of health can possess.

"Great Britain has given the most satisfactory answer to this question. Parliament more than 40 years ago recognized that the highest of all human rights is the right to live, and that a distinction should be drawn between living and existing. Lord Shaftesbury's act of 1851 remained for the most part a dead letter, but the Torrens and Cross Acts of 1868 and 1879 and the artisans' dwelling acts of 1882 effected something, while the housing-of-the-working-classes act of 1890 stands for model legislation and is doing much good. The distinctive feature of this last measure is expropriation by public authority, upon fair terms, of hopelessly insanitary property. Previous enactments gave the right to condemn insanitary houses, and even considerable areas, but their fatal defect was that based upon rental value; the slum-landlord had the advantage. More than that, the law gave him an additional motive for packing his tenements and raising his rent-roll to the highest possible limit. He was just so much better off when a jury of condemnation came to sit upon his case. But the act of 1890 changed all this. No allowance is now permitted for compulsory purchase, the price of the land being fixed at a fair market-value. If the property, or any part of it, is so bad as to constitute a nuisance, deduction is made from the value of the house for such an amount as would secure abatement and wholesome repair. If, however, the premises are unfit for human habitation or are structurally so bad that they cannot be made sanitary, salvage from the building is all that is allowed. These are terms upon which owners of rack-rented ramshackle tenements are treated; and who will say that they are not absolutely fair?" Both American and European laws permit expropriation for works of public utility, but not for purely sanitary reasons, and Mr. Gould urges that the power of expropriation should be extended to meet this requirement. Taxpayers, landlords, and tenants are all guaranteed fair treatment under English practice. The first step is an 'official representation' made by the health officer to the municipal authorities, stating that within a certain area there are houses, courts, and alleys unfit for habitation; that in this area the general health of the community is bad; that certain prevalent diseases are probably caused by the unhealthy conditions of the houses and streets, or by want of proper ventilation or conveniences; and that the evils are not susceptible of remedy without an improvement scheme. The health-officer is required to inspect and report upon the condition of any area upon the complaint of two justices of the peace, or of twelve rate-payers, or he may act upon his own volition. The local authorities examine the 'representation,' declare the area unhealthy, and proceed to formulate an improvement scheme. Members in any way pecuniarily interested are excluded from voting. The improvement scheme, accompanied by maps, particulars, estimates, and statements of arrangements made for securing accommodations for displaced working-people, is then submitted for approval to the local government board, which is in one sense a national department of health. The details of the scheme are made public by advertisement, and notice is given to owners and occupiers. The local government board, having approved the plan, submits it to parliament for confirmation."

Having thus named the remedy, the author proceeds to discuss the mode of applying it in American cities in such a way that the cost would be distributed upon not only the present, but a future, generation; and he evidently regards the English method of dealing with slums as the best study in legislation directed to their extermination.

Workmen's Funds.

MR. GEORGE LIVESEY, in *The Gas World*, May 11, ably discusses the subject of workmen's funds for sickness, accident, old age, &c. The great change in the relations of employers to employed is very forcibly set forth in this paper.

"It has been said that the way to deal with labor is to make use of it so far and so long as it answers the purpose, and then to cast it off. Employers are not so much to blame for this opinion, because it is the direct outcome of the policy of the trade unions. Humanity and the common sense of the employers prevent the general adoption of this hard and short-sighted system, of which the only possible justification would be the impossibility of something better; and, happily, better things are possible. When businesses were small and master and men lived together, and where fair and considerate treatment prevailed, mutual goodwill was the result Now such friendly personal relations are impracticable, partly because in large businesses employers cannot know thei men individually, and partly because they and their men and the circumstances o both have changed, and separation, with prejudice and mutual want of confidence are the rule. The old relations of master and servant are gone beyond recall; the object now must be to make the new relations of employers and employed better than the old. To say this cannot be done is to admit that the industrial world is retograding in its most important particular, for the men are more than their work It is more important that men, in the highest and best sense, should be made than any mechanical or industrial work they can accomplish. If, therefore, employers and employed are to be, and to remain, at enmity, the new is undoubtedly worse than the old; but we need not despair; the prize is well worth winning, but like all other good things, it can only be won by well-considered, patient endeavor The employer occupies a position in which he may exert great influence with his men and ought to be, as he may be, their natura leader. If he does not take this position so-called 'labor leaders' will do so, who would speedily lead the men, themselves and the nation to ruin; they have gone some distance on that road already, and to show that they would do it is only necessary to quote the Collectivist resolution carried by 219 votes to 61 at the Trade Union Congress held at Norwich last year 'That in the opinion of this congress it is essential to the maintenance of British industries to nationalize the land and the whole of the means of production, distribution, and exchange, and that the parliamentary committee be instructed to promote and support legislation with the above object.' To do them justice, one o the oldest and strongest trade unions i the country,—the boiler-makers,—led b their secretary, Mr. Knight, have, in consequence of this resolution, formally withdrawn from the congress."

To many all this may, at first, seem foreign to the question under consideration, but it is not so. Not only have employers and employed got out of touch, but the tendency is to still greater separation. The necessity of reëstablishing satisfactory relations is pressing. "How can mutual confidence and goodwill be created? The men are suspicious and the employers doubtful as to the course to take, which necessarily tends to inaction. There is no one panacea; but this is certain,—that justice. liberality, sympathy on the part of the employer, will tell. It is he who must make the first move, and, as a step in the right direction, workmen's funds for sickness, accident, old age, &c., are recommended. There is an impression that such funds are common, but there are many prosperous . . . . accounts in which there is no item giving evidence that any such fund is in existence. If not, why not? Is it due to want of thought or want of will, or to difficulties, real or imaginary, that stand, or appear to stand, in the way?"

The trade unions appear to have arrayed themselves against all funds involving the association of employers and employed. They do not want either the ties between these two classes to be strengthened, or their hold upon the workmen to be weakened. In spite of this obstacle, the initiative step should be taken, and the employers should take it. The proper initiative is for an employer to call a meeting of the employees, in which the project may be discussed and a plan for carrying it out agreed upon. Statistics of the results of such funds as have already been organized are given. These figures prove at what small cost of trouble and money-responsibility provision can be made for relief of those temporarily disabled by sickness or accident; but they do not touch the larger questions of permanent relief and old-age pensions, for which a separate fund is necessary. "The subject of old-age pensions is one of the burning questions of the day." Germany has recently instituted a compulsory national system, while in England a royal commission has just repeated that nothing effective can be done by the State. In the case of the salaried classes, the government and many public bodies, joint-stock companies, and even private firms, make provision for superannuation by means of joint funds, and the system is very rapidly extending. "It is, in fact, becoming recognized as right and necessary, on the ground that the employer does not feel justified in dismissing an old servant when he becomes infirm, while he also feels that it is not fair to expect him to give a pension towards which the recipient has contributed nothing. The usual plan is for the salaried official to contribute a certain percentage—usually 2½ per cent.—of his stipend, to which the employer adds a like amount. Retirement takes place at 65 years of age, and the pension amounts to, but never exceeds, two-thirds of the then annual salary, if the length of service extends to 40 years or more, and one-fortieth less for each year short of that period. The fact that in the case of clerks and salaried officials the system of old-age pensions is accepted as correct, and remembering that their salaries are usually paid during temporary absence from sickness, is a good reason for making a similar provision for wage-earners."

The Doom of the Small Town.

UNDER the above title *The Forum* for April had a paper written by Mr. Henry J. Fletcher, in which the effect of changed economic conditions is considered, as manifested by the decadence of industries formerly conducted in small towns and the centralization of these industries in larger cities. Consolidation of these industries is the present tendency, and its results are far-reaching. This article attracted wide attention, and has, of course, been variously commented upon in other publications. The best review of Mr. Fletcher's paper that we have seen is one entitled "Economy of the Large" in *Social Economist*, which points out that the large is superseding the small in all commercial and social economics. "Substituting the word 'building,' or 'store,' or 'hotel,' for 'town,' a like essay might have been written on the doom of the small building, the small store, the small hotel or boarding-house, and even the small park, the small church, and the small newspaper. Within 20 years past the small woolen factory disappeared rapidly before the large woolen factory; and during the 50 years preceding the small cotton factory had yielded to the large, as during the 50 years before that the domestic or home system of spinning, weaving, and shoe-making had gone down before the factory itself. The consolidation of many small railroads into a few large ones, and of many small oil and sugar refineries into the Standard, Havemeyer, and Spreckels trusts, is part of the same process. The substitution of large for small farms in England and Ireland, and the higher profits of ranch stock-raising, of Australia and Montana great flocks, of bonanza wheat-growing in California and Argentine, and even the gathering of upwards of sixty petty German principalities into one modern German empire, and the determination manifested in the United States in 1860 to 1865 to have one grand republic rather than a heterogeneous litter of small State-lings, are illustrations of the same idea in so many fields that Mr. Fletcher, to make his title comprehensive, should have omitted the word 'town' and written of the 'Doom of the Small,' absolutely."

Among the statistics given by Mr. Fletcher, it is shown that in Illinois out of 1424 townships 800 have lost population in the decade between 1880 and 1890, 45 have remained stationary, and only 579 have gained. In Ohio 755 townships have lost population, 32 have remained stationary, while only 529 have gained. "In Indiana, Iowa, and Michigan, the number of townships which have lost population is barely in excess, but not greatly so, and all seem to be evidently approaching the period of greater loss than gain."

At the same time the population of these States as a whole is increasing. Only one inference can be drawn from these figures; the loss of the smaller towns is the gain of the larger. But this kind of change, look where we will, has its analogue in all sorts of business. "Years ago, St. John's Park, in New York city, was taken for a freight depot because it was too small to be valuable as a park after the people had got Central and Prospect, Van Courtland, and the other Annex parks. Now Bryant Park is about to be taken for a library, because, while it is too small for a park, it will be large for a library. Seventh and Eighth avenues are filled with small stores which, when certain articles in their line are called for, reply: 'We haven't call enough for that to pay us for keeping it. You can get that at Macy's.' Thus they constantly advertise the competitor that is crushing them. Canal street has sunk in value to half or a third of its value 30 years ago, and its buildings have been for years nearly unrentable, and will continue so until the high buildings break in upon its lethargy and it becomes a vast wholesale street with buildings averaging twenty stories in height. Washington square was going to ruin for its old uses, but the first twelve-story building has invaded it, and the rest will follow."

Without further quoting the examples of the change noted in New York, the cause assigned for it is worth considering. "There has never been any difficulty in perceiving that the migration from the small factory to the large, or from the petty charcoal furnace sending up the smoke of its pig-iron smelting from a single lone chimney-stack in the mountains to the vast concern employing twelve thousand to twenty thousand men and turning out everything from a locomotive to a needle, was a necessary part in the normal evolution of industry. Is the flight from the small town to the great of the same nature and induced by the same causes as the movement of trade in cities from the small stores to the large ones,—*viz.*, to effect an increased economy of time, capital, and nerve-force, or, in short, to net a larger return to both merchant and customer at the same cost. If so, it is a ground of rejoicing only."

The Inter-State Commerce Law is held by Mr. Fletcher to be largely responsible for this decadence of the small towns. Commenting upon this opinion, *The Rail-*

way Review (May 11), which, under the title "The Re-location of Industries," also editorially reviews the *Forum* article, maintains that the cause of these changes, or at least one potent cause, is "that in most cases they [the industries] were unnaturally located, and, in order to maintain a profitable existence, were obliged to be subsidized, either by the town in which they were situated or by the railroad on which they depended for transportation." Doubtless both the causes have had their influence; but in our opinion the most potent cause, which is, indeed, included, though not specifically named, in that assigned by *Social Economist*, is that the vast increase of machine-production has crowded out the manual processes which a few years ago constituted the trades and industries of small towns. As the use of machinery has lessened cost of production, and has compelled concentration in large establishments of industries that once prospered in a smaller way, the natural tendency of population is toward the great industrial centers, and the tendency of industrial location is toward centers of population.

Why Municipal Reform is a Failure.

IN *The American Magazine of Civics* for June, Mr. Charles E. Burton writes that the failure of municipal reform cannot be questioned. "There was a time when any abuses or corruption that might happen to come to light in some particular city seemed to be a shock to the community; seemed to bring to bear in some degree a force of public opinion that carried with it at least a hope of victory over those who were, in effect, engaged in piracy upon the community's treasure. That conditions have changed in this respect, more especially during the last decade, cannot be denied. Nor is there any ignorance abroad upon the subject of corruption in city government. . . . .Any well-informed New Yorker has known for years practically all that has been proved by the Lexow investigations. These investigations . . . only brought out special instances of corruption, and succeeded in adducing legal proof of them."

The author then sets out on a search for reasons and causes, and says that, having inquired of "various persons of intelligence," he has found (as he ought to have expected) "a curious diversity of views, both as to causes and remedies," which he epitomizes as follows:

"(1) 'The foreign voter.' Remedy: anti-immigration laws. (2) 'Ignorant voters.' Remedy: compulsory education. (3) 'Decline in public morality.' Deplorable, but no definite remedy proposed. (4) 'Drink evil,' with its concomitant corruption. Remedy: prohibition. (5) 'Socialistic teachings.' Remedy: individualism. (6) 'Individualism.' Remedy: socialism." Mr. Burton then asserts that not any or all of these reasons "account for the widespread and seemingly mysterious indifference of a majority of the voters in large cities in regard to waste or robbery of the public funds."

As to the first reason it is asked: "Was not our nation with all its cities created by immigrants and their descendants? Why, then, is it so suddenly alarming that our kith and kin are still coming to join us?" Of the second it is alleged that "the proportion of ignorant voters is annually decreasing under the influence of our common-school system and widespread current literature." As to the third reason, "there are abundant reasons for thinking that the public conscience was never more sensitive and awake than at present." As to the evil of drink, "the very fact that it has become a more potent factor in politics is only concomitant to the very condition we are discussing." Socialism "is not yet sufficiently prevalent to produce an appreciable effect upon the body politic in municipal government."

"Standing on the ocean beach, one sees the perpetual roll of waves toward the shore, and wonders how there can be danger for the bathers; but the student of science knows that underneath the surface there is a silent current, known as the 'undertow,' which sometimes overcomes and drags under the strong-limbed bathers. The student of sociology knows that underneath all the talk about the rule of the majority there is a dangerous undercurrent of indifference in regard to what shall become of the public funds,—a feeling among the majority of the voters that the public funds are not their funds. In brief, this may be expressed as an alienation from the commonwealth, a feeling among the employed, non-property-owning classes that they have no part in the common wealth of the community. It is this alienation from the commonwealth that constitutes the dangerous political undertow; for, preach in politics as we may, so long as a majority of the voters believe that a robbery of the public funds is in no sense a robbery of their funds, just so long will they remain indifferent to it.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Industrial Sociology in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

31639. Claims of Bimetallists (Soc Ec–May.) 3000 w.

31640. The Economy of the Large (Soc Ec–May.) 2000 w.

31641. Public Effects of Great Fortunes (Soc Ec–May.) 1900 w.

31642. Prices and Volume of Money (Soc Ec–May.) 1800 w.

31643. A Colonial Experiment in Communism (Soc Ec–May.) 2400 w.

31644. The Secrecy of the Legislation Against Silver (Soc Ec–May.) 2100 w.

31676. The Commercial Union of the States. Chauncey M. Depew (Ry Rev–May 11.) 2200 w.

*31681. The Silver Question. Prize Essay by George Jamieson. 6000 w.

*31682. The Rise in the Value of Gold. Thomas Holyoake Box 4000 w.

*31683. The Fall in Silver and Its Effect on British Trade. David Octavius Croal 7000 w.

*31718. The Currency of the United Kingdom (*Bank Mag*–May.) 2600 w.

*31719 The Trade Revival in the United States. W. R. Lawson (*Bank Mag*–May.) 5600 w.

*31756. The Commercial Capital of Canada (*Trans*–May 3.) 3500 w.

31157. The Re-location of Industries. Editorial (R'y Rev–May 11.) 900 w.

*31769. Homes for the People. William E. Smythe (Milling–April.) 1400 w.

*31770. The Free Coinage of Silver on the Old Basis. Denison B. Smith (Milling–April.) 1600 w.

*31773. Clumsiness of Existing Electoral Methods. T. W. Graham (Milling–April.) 900 w.

†31776. Factory Legislation for Women. Evelyn March-Phillips (*Fort Rev*–May.) 5000 w.

31780.—$1. The Exploitation of Theories of Value in the Discussion of the Standard of Deferred Payments. Frank Fetter (An Amer Acad–May.) 5000 w.

31782.—$1. The Units of Investigation in the Social Sciences. Arthur F. Bentley (An Amer Acad–May.) 57500 w.

*31929. Workmen's Funds, for Sickness, Accident, Old Age, &c. George Livesey, with Discussion (*Gas Wld*–May 11.) 8800 w.

*31952. How Many Woman are Going into Business. Martha J. Owens (Chau–June.) 2000 w.

*31999. French Share of the Trade of Japan (*Bd of Tr Jour*–May.) 900 w.

*32001. Tariff Changes and Customs Regulations. Russia, Norway, Germany, Netherlands, France, Spain, Roumania, Greece, Persia, United States, Nicaragua, Trinidad and Tobago, British Honduras (*Bd of Tr Jour*–May.) 8000 w.

*32016. The Nicaragua Canal. Editorial (*Fairplay*–May 17.) 1600 w.

*32023. Compulsory or Voluntary Conciliation. Dr. Robert Spence Watson (*Ir & Coal Tr Rev*–May 17.) 4000 w.

*32026. Imperial Federation: Its Relation to British and Colonial Trade. Anon. (*Ir & Coal Tr Rev*–May 17.) 3000 w.

*32086. Progressive Individualism. John R. Commons (Am Mag of Civ–June.) 5000 w.

*32087. Is Monopoly Always Victorious? Gilbert L. Eberhardt (Am Mag of Civ–June.) 1600 w.

*32088. The Issue in Ninety-six. A. J. Warner (Am Mag of Civ–June.) 2700 w.

†32094. Power and Wealth of the United States. Michael G. Mulhall (N Amer Rev–June.) 2600 w.

†32096. The Silver Question. I. Germany's Attitude as to a Bi-metallic Union. Count von Mirbach. II. The Silver Standard in Mexico. M. Romero (N Amer Rev–June.) 5500 w.

32117. Deserts the Hot-bed of Populism (Soc Ec–June.) 2800 w.

32118. Ship Subsidies and Bi-Metalism (Soc Ec–June.) 1000 w.

32119. The Duty of Protectionists Towards Ocean Navigation. William W. Bates (Soc Ec–June.) 1300 w.

32120. The Gratuitous Benefactions of Capital. T. B. Stork (Soc Ec–June.) 4500 w.

*32121. The Growth of American Nationality. Francis A. Walker (Forum–June.) 6800 w.

*32122. The Free-Silver Argument. W. H. Harvey (Forum–June.) 5800 w.

*32123. The Grotesque Fallacies of the Free-Silver Argument. J. DeWitt Warner (Forum–June.) 3400 w.

*32125. The Only Cure for Slums. E. R. L. Gould (Forum–June.) 2600 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Structural Weakness of Steamers.

A PAPER of unusual import, in view of the recent breakdowns of machinery—especially of shafts—on ocean steamers, was one recently read before the Institute of Marine Engineers at Stratford, England, by Mr. John McAllum, and reported in *Engineers' Gazette* for May. While it has long been believed by some, and disputed by others, that vessels deflect in loading, "it has been clearly demonstrated, despite the opinions to the contrary, that the forms of vessels do alter; and in the port of Cardiff, which offers special advantages in observing vessels which are constantly trading to and from the port, we have the evidence of those persons responsible for the loading, and who have ample opportunities of verifying their statements, that under different conditions of loading different weights are carried, water ballast and coal remaining in bunkers being allowed for. If we are to believe these statements, is it surprising to hear of detention and subsequent prosecution for overloading? In many cases there are doubtless evasions of the law, but in others the submersion of the disc is not entirely due to weight carried, but to the manner in which it was put in the vessels; and there is reason to doubt that the vessel has an excess of cargo over her usual complement."

Theories advanced in the past have attributed the failures of marine engines and shafts to bad material, bad workmanship, and faulty design; but the structural strength of the steamer, its deflection and working in a sea-way, is, the author contends, one of the main points of weakness. Particulars of a series of observations taken on board a steamer of 3000 tons net register, notorious for the breaking of her shafts, are given as follows:

"The vessel was well built and of a superior class; engines triple and well-balanced, both hull and machinery being constructed by first-class builders. On the second voyage one shaft broke, and within 2 years four lengths of shafting were either broken off or condemned, the material in every case showing itself solid at the fractures and of the best quality. The shafts were made of the best selected iron, and 20 per cent. in excess of requirements. Observations in the first instance were taken in the shaft tunnel by the engineer of the steamer, by means of a steel wire, 19 B. W. G., running parallel with and directly above the center line of shafting, one end of which was secured to the engine-room bulkhead, and the other conveyed over a small pulley, 6 in. diameter, acting in a suitable bracket, which was bolted to the after bulkhead in the tunnel, and the wire was kept taut by a weight of 46 lbs. suspended at the end. The distance from bulkhead to bulkhead was about 112 ft., and midway between a square graduated rod with a jaw end, in which a pulley acted, was brought into contact with the shaft and kept in the vertical position by means of two projecting brackets of light design, fastened to the tuunel sides, one above the other, and through which the graduated rod operated vertically, and any difference in the indications was easily noted.

"It may be urged that this method of determining the vessel's movement was crude and unreliable, and that the actual amount could not be estimated with sufficient precision; but, at the same time, it seems clear that, if there was no movement, the indications would remain unaltered. The difficulties which have to be overcome in taking observations in a tunnel are doubtless the principal reasons why we have no record of any; and, when we consider the unfavorable conditions in a dark and confined space in which a shaft is revolving, the method adopted by the engineer, with the means he had at his disposal, recommends itself as ingenious. The result of the observations was with ship loaded, draft 24 ft., with a heavy confused sea on starboard beam and quarter, engines racing occasionally, and vessel lurching and pitching about 18 to 20 ft., a maximum movement of 1¼ in. vertically. This was the greatest deflection seen, happening invariably when the steamer's stern was high and the seas passing between Nos. 2, 4, and 5 hatches. The ordinary amount observed when the vessel was pitching in a head sea about 10 ft. forward was from 1¼ in. to 1½ in. No change took place when in port, for, as a rule, the holds were discharged together and loaded together. With engines stopped at sea, the wire resumed its normal position exactly as in port, and, on restarting and getting under weigh, the graduated rod indicated a deflection of ⅜ of an in. in smooth water, the vessel's stern showing a downward tendency which was attributed to the movement of the propeller."

Observations made on deck by means of sight confirmed the observations made in the shaft tunnel. In one experiment a downward deflection of ¾ in. at the stern was noted. "Working under these conditions of hull movement, a squeaking noise was heard in the tunnel; this was located in the after couplings, and, on this noise increasing, the engines were stopped for examination, when it was found that the coupling bolts were loosened, and the nuts could be tightened up one and a half panes more or less. On former occasions it was noted that the bolts had behaved in a similar manner, and for closer observations the nuts had been marked accurately on to the bolts, and the bolts were alike marked on the chart; so it was clearly evident that the bolts had elongated due to the strains set up through the vessel's movement. After the bolts had been carefully refitted, the trouble would cease for about 3 months. This steamer's hull was afterwards strengthened, and up to the present there has been no further complaint."

Flexible couplings and stiff springs under the tunnel blocks have been successfully used to obviate the bad effects of the deflection of hulls upon the machinery. In the discussion which followed, Mr. J. F. Flannery said that putting engines aft in tank steamers increased vibration and caused serious local strains upon the after part of the ship.

Water-Supply on Board Ship.

FOR insuring a fresh water-supply on board ship attention has been assiduously directed to the invention and designing of apparatus whereby sea-water can be made potable. As sea-water contains large quantities of soluble salts, the principal part of the problem has been to effect the separation of these salts from the water that holds them in solution. Thus far this has only been possible by distillation, the distillate being water and the salts remaining in the still.

A new and very effective apparatus for this purpose is described in *Transport* (April 12.) This apparatus differs from all the devices that have preceded it, and obviates the necessity of the brass or copper condenser-tubes hitherto employed. These have been a frequent source of trouble through scaling and corrosion. The formation of scale reduces seriously the efficiency of the condenser, and thus an apparatus which at the beginning may have been of ample capacity may prove to be deficient just at the time when it is most required; and, when it is put into service, it usually demands a great deal of cleaning and overhauling. Any apparatus which will obviate these drawbacks will be a welcome addition to marine appliances, and the claim is made for the new apparatus (called "The Henneberg," after its inventor) that it completely removes them.

"The condenser is formed by a number of plate elements which are provided on both sides with channels cast of special form. Between these elements are placed thin tinned copper sheets, which shut off the channels of one element from those of the other. The channels of the different elements, both above and below the copper sheets, are connected by pockets, cast on the side of the elements, and by this means two entirely separate systems of channels are formed, and kept asunder by the copper sheets already mentioned. If one of these channels is fed from above with steam, and the other from underneath is supplied with cooling water, the steam—*viz.*, the vapor from the evaporator—and the cooling water are moved along, after the counter-current system, and in such a manner that an extremely rapid exchange of heat takes place between the two liquids. In such transformation the highest efficiency is secured in a comparatively small apparatus, and a refrigeration of the condensate is thus obtained which could not be secured in tubular condensers. The following data, which have been taken from practical working with the vapor at a pressure of 11 lbs. per sq. in., demonstrate the merits of the apparatus :

"(*a*) Cooling effect such that the difference between condensed drinking water and the cooling water entering the apparatus was only 25° Fahr. (1) Capacity per sq. ft. condenser surface, 80 gallons of drinking water per 24 hours. (2) 100 gallons of drinking water per hour are produced with a condenser; weight with water added, 42 lbs. (3) Quantities of cooling water, about 8 times as much as the condensate. Final temperature of cooling water, 194° Fahr.

"(*b*) Cooling effect such that the difference between condensed drinking water and the cooling water entering the apparatus was 5° Fahr. (1) Capacity per sq. ft. condenser surface, 134 gallons of drinking water per 24 hours are produced. Weight of condenser, weight of water included, 27 lbs. (2) Quantity of cooling water about 8 times as much as the condensate. Final temperature of cooling water, 194° Fahr."

These figures indicate great efficiency. They are said to have been taken from large installations. The superior efficiency over tube-condensers is doubtless due to the rapidity with which the cooling water circulates over the condenser-plates. In tube-condensers "the construction and design arrest the velocity of both water and vapor, thereby raising the temperature of the distillate, and to a great extent assisting in the deposit of salts and scale on the tubes, necessitating the constant cleaning of the entire apparatus, and entailing much trouble. Further, in comparing the weights of the different types with their efficiencies, it will be found that the plate system has a most substantial advantage. One of the most important, or what may be accepted as the most prominent feature in favor of the newly-introduced system is the perfect aeration of the vapor in its passage through the condenser. Owing to the violent process of condensation, and the rapid cooling of the condensate, all the air which is expelled from the sea-water is reabsorbed, and the water is produced as a clean, cool liquid, having all the qualities and ingredients of natural water, with a taste almost equal to that obtained from a spring or well. In tubular condensers such a product never can be obtained, as, even in spite of all the many recently-improved arrangements of aeration, the water gathered from tubular condensers generally tastes insipid." The new apparatus is stated to have been adopted in war vessels and transports, and a famous firm of marine engineers is now engaged in its manufacture.

The Defender.

THIS sloop yacht, designed to defend the cup against the English contestant that will be sent over to take it away, if possible, this summer, has been built under the impression that the coming contest will be the most severe yet experienced by American yachtsmen. Probably no sporting event of the year will so generally excite interest throughout the country as this, especially among naval constructors and marine engineers. Every effort possible will be exerted on both sides. It is not merely a race that will be involved, but the question of ability in marine design and construction as between America and England. *Scientific American* (May 25) describes the Defender probably as well as she can be described under the restrictions imposed.

"The exact measurements have not as yet been made public; for from the time of their conception until long after launching the cup-defenders have ever been mysteries to the public, and the present yacht is, if anything, more so than the preceding ones. This secrecy must be maintained, so as to keep the lines and dimensions from rivals and those interested in the challenging yacht. The present figures, although in some instances unofficial, will probably be but little out when comparison can be actually made.

"The Defender is not far from 126 ft. over all, and between 80 and 90 ft. at the water line. The beam is about 23 ft., draught about 19 ft. She has no auxiliary center board forward, but is an out-and-out keel boat. She has a 35-ft. lead bulb weighing 60 tons. In the lead bulb of the Defender, Herreshoff has remedied a serious defect that existed in the Vigilant. Where the latter in a heavy sea pounded with her flat outside ballast, the Defender will rise and fall without pounding, as the egg-shaped form of her ballast gives easy entrance and withdrawal. The Tobin bronze plates, as used in the Vigilant, have been superseded by manganese bronze plates below the water line; and above it, as far as possible, they are of aluminum, with an alloy of about 10 per cent. of copper to resist corrosion and give added strength.

"Not only is the upper portion of the plating of the Defender of aluminum, but the deck beams themselves are of the same material, and the saving in weight over steel will be more than double the amount saved by the plating. The total saving effected by the use of the aluminum is estimated at seven tons, which is expected to tell greatly in favor of the Defender in the races. A dispatch from Boston states that the mast is 102 ft. long; topmast, 61 ft., 2 in.; spinnaker pole, 72 ft. These dimensions may be slightly decreased in fitting. It is said that the Defender will have 7000 sq. ft. of canvas in her mainsail alone, and her total sail area will be from 12,500 to 13,000 sq. ft. The distance from the deck to the hounds will be about 72 ft. The Defender's principal gain in sail area will be in the mainsail, the spinnaker being somewhat smaller than that of the Vigilant. One of the most interesting features of the Defender is the manner of working the sails. All the halliards will be led below, where they can be worked by means of powerful winches. The main sheet will also be led below, where it can be handled by a few men with the aid of a winch. Possibly the same may be done with the sheets of the head sails, but many of the details of the yacht are still kept secret. Much of the heaviest work of trimming sheets can be thus carried on below the deck, leaving the deck itself clear for other work."

A fancy sketch of the boat, as an artist has imagined she may appear, accompanies this description. It is pretty, but is, of course, merely a pictorial guess.

The Screening of Side Lights.

FAIRPLAY says that even among experienced seamen very loose and inaccurate notions appear to prevail as to the exact function performed by side-lights. The fact is the existing system has been accepted by the majority of seamen without any investigation. Side-lights have been supposed to project sectors of green and red light in a purely conventional manner which is well illustrated in the "Rule of the Road" by the late Mr. Thos. Gray, of the London board of trade. In that publication it will be seen that the rays emanate from a point. As a matter of fact, light issues from the lantern in a different manner altogether, and it is this difference between the conventional and the actual which lies at the bottom of the whole controversy. It is a well established optical principle that "every luminous body emits divergent rectilinear rays from all its points and in all directions." Applying this principle to ships' side-lights, we see that from every point on the luminous surface of the lens rectilinear rays diverge in all directions.

It will be seen that in the latter case the effect is to produce a sector of light extending over a larger arc than in the former case. The error which the nautical advisers of the board of trade and the majority of seamen have fallen into consists in regarding the rays as emanating only from the wick; the rays of course do so emanate, but they illuminate the lens, and it is the rays from the lens which meet the eye of the observer. We may say that the larger the lens the larger is the arc over which the direct and secondary rays extend. It is the presence of the lens which makes it so difficult in lighthouse work to throw a sharply defined sector of light over a given area, or rather, the lens increases the difficulty of defining the limits of the sector. As an instance of this we may mention the Longships light. The writer has frequently noticed that when steaming past this light there is a considerable sector of overlapping red and white rays. Applying the foregoing principle to the case of ships' side-lights important conclusions follow. Sir Donald Currie speaks of a steamer whose lights were screened to the 4 degree angle: he said "the lookout man on watch on the forecastle head of that ship is unable to discern an approaching steamer, as he is blinded by the glare of red and green in advance of his ship." This will at once be recognized as a matter of first importance in marine engineering. How many accidents have resulted from improper screening of side lights it is impossible to say. Some cases wherein carelessness has been charged are explicable from the fact that people expected to see sometimes cannot see.

Current Leading Articles on Marine Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

31627. The American Naphtha Launch. Ill. (Am Ship-May 9.) 900 w.

31703. Screw Steamer and Steel Tow-Barge Efficiency. Joseph R. Oldham (Can Eng-May.) 2200 w.

*31754. Deviation of the Compass. A. W. Reinold, with Discussion (*Jour Soc of Arts*-May 3.) 5000 w.

*31760. Experiments in Connection with Evaporation. Ill. D. B. Morison (*Marine Eng*-May.) 6000 w.

*31761. Induced Draught as a Means for Developing the Power of Marine Boilers. W. A. Martin (*Marine Eng*-May.) 1000 w.

31806. The Marine Gasoline Engine and Gas Engine Boat. Ill. (Sci Am-May 18.) 900 w.

31808. The Layman Pneumatic Sporting and Outing Boat. Ill. (Sci Am-May 18.) 800 w.

*31820. Doxford's Boat-Lowering Gear. Ill. (*Eng Gaz*-April.) 600 w.

*31821. The Structural Weakness of Steamers and Its Influence on the Propelling Machinery. (Abstract.) John McAllum (*Eng Gaz*-May.) 1500 w.

*31850. The Story of Shipbuilding on the Tyne (*Eng*-May 10.) 1300 w.

*31886. The Waterways of Germany (*Fairplay*-May 10.) 1600 w.

*31887. Lights in the Gulf of Aden. Anon. (*Fairplay*-May 10.) 900 w.

31947. The American Yacht Defender. Ill. (Sci Am-May 25.) 1000 w.

31949. Improved Boat-lowering Devices.—Suggestions of Commander Tupper (Sci Am-May 25.) 900 w.

*32000. Extension of Japanese Maritime Communications (*Bd of Tr Jour*-May.) 800 w.

*32005. Japanese Shipping. Editorial on paper by Francis Elgar (*Engng*-May 17.) 1800 w.

*32006. The Development of Naval Ordnance. Editorial (Engng-May 17.) 3000 w.

*32009. Stability of Tank Steamers. W. Hök (*Engng*-May 17.) 5000 w.

*32052. The Harbors of Cape Colony (*Trans*-May 17.) 1700 w.

32111. Leak Arresters for Ships (Sci Am Sup-June 1.) 1000 w.

32211.—$1.25. Laws of Similitude Regarding Questions of Naval Construction. J. A. Normand (*Jour* Am Soc Nav Eng-May.) 4500 w.

32213.—$1.25. Machinery of British War Ships. Ill. Albert J. Durston (Jour Am Soc Nav Eng-May.) 7000 w.

32214.—$1.25. Tubulous Boilers in the French Navy. John K. Robison (Jour Am Soc Nav Eng-May.) 17000 w.

*32241. Lighting the Magellan Straits (*Fairplay*-May 24.) 700 w.

*32243. The Screening of Side Lights. Ill. (*Fairplay*-May 24.) 1700 w.

*32258. The Screw Propeller. Ill. W. C. Winterburn (*Prac Eng*-May 24.) 3500 w.

*32262. Stern Tunnels of the Olympia. A Criticism and a Reply Thereto (Ind'y-June.) 2500 w.

*32264. Old River Engines. By an Old-Time Steamboatman (Ind'y-June.) 1700 w.

32296. The United States Battleship Oregon. Ill. (Sci Am-June 8.) 400 w.

32301. The New American Steamship, St. Louis (Sea-June 6.) 600 w.

*32351. Submarine Navigation (*Eng*-May 31.) 1100 w.

Serials.

16636. Marine Engine Design. Ill. (*Mech Wld*-Began Oct. 6, 1893—24 parts to date—30 cts. each).

30466. Protection to Agriculture and Shipping—The Lubin Proposition Considered by Our Shipbuilders (Sea-Began March 28—4 parts to date—15 cts. each).

31818. The Drawing Office. Ill. Archibald Denny (*Mech Wld*-Began May 10—Ended May 17—2 parts—30 cts. each).

32208. The New British Cruiser "Terrible." Ill. (*Engng*-Began May 24—2 parts to date—30 cts. each).

32353. Breakdowns at Sea. W. Welbury (*Eng*-Began May 31—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Compressed Air in Foundry Work.

MORE and more are the uses to which compressed air, as a storehouse of energy, are extending, In one line of industry—foundry work—Mr. Howard A. Pedwick, of Philadelphia, in a paper read before The Foundrymen's Association in that city May 1 (*Iron Age*, May 9), suggests further useful applications of compressed air, "which will be found a giant in strength, and at the same time a clean, safe, and docile power to handle." The use suggested would entail some extra coal for plant, but "the average foundry work would not need a very extensive or costly plant. The compressor, which is the starting part of an installation, has to be considered. To avoid trouble and expensive maintenance, it is desirable to obtain a machine calculated to furnish the needed volume of air with as little power as possible. Then, too, since the air will be used intermittently, the machine is better adapted if automatic in its action, thereby dispensing with any attention other than oiling. This automatic action is controlled by the variation of air pressure, causing the machine to start up when the air is being used, and to stop when the desired pressure is obtained, thereby saving power, wear and tear, &c. Durability and simplicity must not be lost sight of, since around the average foundry there are not always available men to overcome the little tricks that a great many air-compressors are more or less subject to. The air supplied for foundry purposes, too, must be dry, so that exhausting from a hoist or other apparatus may not cause a miniature shower in the nature of spray. The larger types of machine often use water for cooling the air under compression in the compressing cylinder, which causes the exhaust to act thus objectionably.

"Cooling the air by a water-jacket around the cylinder is preferable, not only from the fact of having dry air, but because it avoids the danger of water getting into the cylinder and causing its destruction. Clearance between piston and cylinder-heads must be reduced to as little as possible, so as to eject all the compressed air at every stroke. Without doing so, the air, necessarily heated under compression, expands, and will not allow the cylinder to take in its full capacity of free air, thereby causing the machine to labor without result."

For foundry work Mr. Pedwick regards driving compressors by belts as preferable, on the ground of economy, to driving them directly by steam. But, unless provided with ample fly-wheel, a belt-driven air-compressor is a very jerky, uneasily-working machine, and our choice would be the direct steam-driven type. A store of compressed air in an ample reservoir in a foundry can be utilized in many ways. It can be used to great advantage for all the lifting of flasks, ladles, etc., requiring mechanical aids. Direct-acting cylinders running on overhead trolleys may be so employed, or horizontal cylinders transmitting power by wire ropes may be used. A jib crane actuated by a compressed-air motor is a very useful appliance. The sand blast, the application of which compressed air renders possible, is the best means of cleaning castings ever devised.

The pneumatic clipping-chisel "does vastly more and better work than several men can accomplish in the old way. This little tool weighs about 15 or 20 lbs. It is a cylindrical piece of steel bored out to receive the piston, which is also the hammer. A small valve, controlled by the air pressure, admits air on either end of the piston, causing it to reciprocate very rapidly and to strike a blow at every stroke. The chisel is placed on a shank projecting from the cylinder. A slight pressure of the hand holding the upper end of the tool admits air, which starts the hammer. Externally there is nothing moving; the chisel is kept in contact with the work, as if the operation were a pushing-off process. The amount of work accomplished by this little air tool is surprising, and, where much hand chipping is done, opens a way to very materially reducing the cost and labor for such work."

Other uses suggested are the breaking of scrap and pig for the cupola. The discussion that followed the reading of the paper indicates that leading foundrymen are alive to the advantages set forth by Mr. Pedwick. President Schumann stated that his "company had recently put a sand-blast machine in their works, and, where formerly 2 hours were required in cleaning special castings, the machine did the work in 10 minutes. The only trouble with it was that the operator was trying to do everything with it, even trying to chip out the cores on 12-ft. columns. They were using it on large castings to dispense with the use of facing in the sand. They were using the sand raw on castings weighing as much as 5000 lbs. to 8000 lbs., and the castings ultimately developed a beautiful slate color; yet, when they came out of the sand, it would seem to be a question as to how the sand could be taken off them."

It was further brought out in this discussion that a pressure of from 80 to 100 lbs., by gage, had been proved the most advantageous for general foundry use. The cost of compressed air in lifting, etc., is more than that of steam, but its cleanliness, convenience, and other advantages are regarded as compensating for this increased cost.

How to Inspect Boilers.

In "Hints on Boiler-Inspection" *Boston Journal of Commerce* (May 4) the following points are noted. First, there cannot, in practice, be a too frequent or a too thorough inspection. The opportunities for doing this without interference with regular work or with holiday recreation will always be few enough. At every opportunity, such as cleaning days, "prepare for a thorough inspection of your boilers, let there be one or one hundred. After removing all ashes and clinkers from the boxes, wash out the boilers, so that an always disagreeable job may be made as pleasant as possible. Next go inside, examine thoroughly the bracing, look for cracks or crow feet where strain comes between rivets, and see if the heating and cooling of the boiler has produced them. If one brace is broken or cracked, see if there are still enough to hold the head until such a time as it can be replaced with a new one, without shutting down. That done, examine the head closely, particularly at the turn of the flange, for checking, which are small cracks produced by any slight movement of the head. This being the short radius of the curve, they will show here first."

Whether these are formed or not should be recorded " for further reference. They are not considered as serious, unless extensive, in which case more braces is the general recommendation." Examine next the shell near the water-line. If corrosion has reduced the thickness of the plate, the remaining thickness can easily be determined by drilling, and the pressure that can be safely carried can be computed for the remaining sound metal.

Examine the scale to see whether it is of the hard, solid, insoluble kind, or of a porous spongy nature. In any case scale should not be allowed to accumulate, but the hard kind is the most dangerous. The remedy to be relied upon is watchfulness and frequent cleaning.

The safety valve, steam pressure, and water gages should all be thoroughly examined, and any defect found in the entire line of inspection should be reported in writing to the company in which the boiler is insured. "Going in over the grates, the condition of the furnace walls should be carefully noted, the circular seams over the fire should be examined for fire-cracks; if any are found, and they run back of rivet into plate, drill small holes at the end of the cracks and put in a rivet; this will stop the crack from extending. If simply a fire-crack is found that is from rivet hole to edge of sheet and showing no signs of leakage, it in itself is not serious, but a note should be made of it for future reference.

"Going back over the bridge wall, which should not be too close to the boiler-shell, examine the flues or tubes for a possible leak. If any are found, see what caused them. If there is any accumulation of scale around the tube end, remove it, roll the tube, and proceed with the examination. Examine the blow-off pipe, especially close up to flange or reinforce-plate on the boiler. A small leak here will soon cut through the pipe and give trouble; and it may, by blowing off, burn the fireman or cause a shut-down at an inopportune time. Should a defect be found which leaves you in doubt whether it would be safe to run, bear in mind that an explosion will cost more than a shut-down, and an error of judgment that shuts the plant down will not cost many lives, while an error in the other direction may."

Long-Distance Power Transmission.

"COMPARATIVE Cost and Efficiency of Electricity and Compressed Air for Transmission of Power to Long Distances" is the title of a pamphlet of 29 pages, 6″ × 9″, written by Prof. Herman Haupt, consulting engineer of the General Compressed Air Company, New York city. As these two methods of transmitting power over long distances are the only ones practically available, and as both are in use, although electricity has, so far, taken the lead, the subject is of immediate importance and interest to mechanical engineers. We are witnessing the infancy of an era of power-transmission from central sources over wide areas. Whether electricity or compressed air shall ultimately become the most favored mode of transmission, doubtless each will continue to have special advantages for special sets of conditions, as is the case with the cable and electric systems of car-propulsion; and both are present and future mechanical resources by no means near the end of their development, but still calling upon inventive skill for further perfection of mechanical appliances.

In our department of improved machinery is described an improved air compressor, showing features of novelty that suggest yet unopened leads in which development may advance.

Prof. Haupt quotes from an article printed in the *Boston Herald* (Feb. 1), not naming the author (stated to be an electrical expert), who writes referring to a previous article in the same newspaper.

The previous article had stated that "the consensus of expert opinion was that, at the present stage of science, when so little was known" and so much yet to be learned, "the transmission of electrical energy from Niagara Falls to distant points could be accomplished only at such a loss of power that it would prove a commercial failure."

"The writer claimed that, 'until dynamos capable of generating currents of at least 20,000 voltage were invented; until the expensive transformers were done away with; until friction could be reduced to a minimum, and induction largely eliminated,—electricity could not be sent over 5 miles and delivered in successful competition with steam. Within a year from the time this was written these opinions were substantiated and admitted by the Niagara Falls Power Company, and by Tesla himself.'

"The Niagara Falls Power Company made application to the city of Buffalo for a franchise to deliver power in that city, but, being required to name conditions as to time, price, etc., the company was forced to say that 'it cannot name a price for electrical power transmitted to the Buffalo city line, as in the question of transmission are involved the uncertainties of the losses and cost of operation and maintenance.' This has ended all questions of supplying distant points, at present, with electricity from the falls. Last week the New York *Herald* announced that Tesla states that it would probably be too expensive and wasteful to attempt to transmit large electrical energy by ordinary alternating currents."

Siemens, Edison, Unwin, are quoted to substantiate the proposition that the commercially practicable limit of electric power-transmission is about 5 miles. On the other hand, Mr. Franklin Leonard Pope, electrical editor of this magazine, is quoted as having stated with reference to a power-plant installed under his design and supervision at Great Barrington, Mass., that, from results there attained, he thinks the Boston *Herald* writer is in error, and that power can be transmitted 20 miles from a turbine and compete commercially with steam-engine power at that distance.

This opinion is attacked by Prof. Haupt, who makes a calculation to show that power transmitted 20 miles from turbines, even with a voltage of 5000,—which Mr. Pope declares he would not hesitate to use,—would cost more than twice as much as steam power generated *in situ*; and he concludes that, unless voltage can be practically "increased much beyond 5000, the idea of electrical transmission to long distances must be regarded as an *ignis fatuus* beyond the possibility of attainment at any cost commercially justifiable."

Now, as to transmission of power by compressed air, the following points are held to be established. (*a*) That ignorance and prejudice have retarded the use of compressed air for power-transmission, (*b*) That, by reheating compressed air, it can, at small expense, be made to yield more power in a motor than it takes to compress it to a given working pressure. Hardie's new air motor, which at Rome, N. Y., has achieved a marked success, is cited as proof of the latter statement. This motor provides for reheating the air before inducting it to the motor cylinder by passing it through a hot-water heating device which increases its volume 100 per cent. under constant pressure, the air being thus heated to the temperature at which steam is ordinarily used and at the same time absorbing about 1 lb. of steam for each 50 cu. ft. passed through the water.

The total of these accessions is stated to be 100 per cent. The increase of volume in the compressed air from reheating alone is said to be fifty per cent. Of course the truth of the latter statement can easily be proved or disproved by resort to mathematical methods. The fact that 50 cu. ft. of air, compressed to 2000 lbs. per sq. in., as in the Hardie motor, will absorb 1 lb. of steam can only be proved by experiment; but, assuming this datum to be correct, the increase in volume due to such absorption can also be determined by the mathematical application of thermodynamic principles. It is not likely that a statement so open to challenge would have been made without knowledge that it can be sustained.

A calculation of the cost of transmitting power 20 miles by compressed air is next presented, and another of the cost of transmission 100 miles, each through 6-in. pipes, the initial pressure being 2000 lbs. per sq. in.; and the conclusion is reached that, even at 100 miles, there would be a slight difference in favor of compressed air over steam-power locally generated, when large turbines are the prime motors. The author concludes his essay with the following significant paragraph:

"Finally, if power should be generated at the coal mines by the use of refuse coal, costing nothing, and transmitted 100 miles in pipes, the cost of the power for 2500 horse-power would be as follows:

"Interest, repairs, and depreciation of the boiler plant, $9375; wages of firemen, $2700; interest and repairs of compressor-plant, $12,000; interest on pipe-line, $15,000; wages of engineers, $4000; total, $43,075; or $17 per horse-power per annum, which would be nearly $10 less than cost of steam-power generated locally."

Experimental Engine Built at Sibley College, Cornell University.

If any proof that the steam-engineering course of study in Sibley College is in the highest degree efficient had hitherto been lacking, it would have been supplied by the experimental quadruple expansion engine, designed by Messrs. Thomas Hall and C. H. Treat, students in that institution, of which Prof. R. H. Thurston is the head. Whatever criticism of this engine may be indulged in, it must be conceded that its design shows a profound knowledge of fundamental principles. It also evinces much inventive and constructive talent. The statement that this engine develops 1 h. p. for less than 10 lbs. of steam challenges belief, as the very best previous record belongs to the Milwaukee pumping engine,—11.67 lbs.

Power for June contains a long illustrated description of the engine. We shall endeavor, in this review of that description, to present a general idea of the machine, though it is impossible, without illustrations, to deal much with details.

"The engine was built in the Sibley College shops, Cornell University; it was designed for an experimental engine, the principal objects of experiment being to find how the economy increases with steam pressure and with speed of rotation. It involves several new features. An entirely new form of valve gear was designed, the prospective high speed of the engine rendering necessary a novel departure in this line. In order to generate the high pressure steam required, a boiler has been built in which it is possible to carry 1,000 lbs. steam pressure; and a special form of brake was designed capable of keeping the load automatically constant. The principal considerations in the design of the engine were, first, that its construction require as little labor as possible, for at best it was to be a large undertaking; second, that it should attain the highest economy after providing for rapid construction."

The means of reducing wastes in steam engines, available to designers, are: "(1) increasing the number of cylinders, and so reducing the range of temperature in any one cylinder; (2) making internal area a minimum, and coating with non-conducting material; (3) jacketing; (4) superheating; (5) high rotative speed."

The design was worked out with reference to a maximum pressure of 500 lbs. This corresponds to a temperature of 467° F. To prevent waste of heat through the escape of fuel gases at and above this temperature, these gases are made to reheat the steam between stages of expansion, passing to receivers serially from those of higher pressure to those of lower. The cranks are at 80° angles, which very closely balance the entire machine. In fact, it is stated that it was run at five hundred revolutions per minute, while simply resting on blocks without being rigidly bolted to anything. The stated low friction loss—10 per cent.—is also surprising for a four-cylinder engine.

A feature showing the inventive skill of the designers is the construction of the induction valve and valve gear. "The steam valves admit through a slot in center, when the slot is over the port. Steam is admitted by one edge of the slot and cut off by the other. These events occur at each stroke of the valve, and consequently the motions of the steam gearing need be only half as frequent as ordinarily, thereby reducing the inertia effect to one-fourth. Spiral gears in the base give this reduction of speed, and drive a short shaft, having cranks instead of eccentrics to transmit the motion to a sliding block movement at the front of the engine. This device operates to give the valves quick movement during the admission period, and reduces over-travel of the valves." This valve gear is ingenious. The exhaust valves are much like the Corliss, and driven by a crank on the end of the shaft. Indicator diagrams taken from these engines show excellent induction and compression lines. The release is uniformly good, in all the cylinders, and the exhaust lines follow very closely the theoretical pressure lines at the end of each expansion. The valve action is therefore much more perfect than is frequently the case in quadruple expansion engines.

Working Stock in Drop Dies.

THE use of drop-forging in machine-construction increases yearly. New machines for all sorts of purposes are coming into existence, and so the desired uniformity and cheapness of production in those involving much duplication of wrought-metal parts is, in the majority of cases, obtainable only by this method. A good practical discussion of the subject of "Working Stock in Drop Dies," by B. F. Spalding, is contained in *American Machinist* (May 16).

The relation which the cost of the dies bears to the cost of a given number of forgings will determine the adoption or non-adoption of the method, except in cases where uniformity is essential, and wherein this is the cheapest and surest method of obtaining such uniformity.

"When it becomes evident that a large number of pieces is to be made, and that the tools for making them will require frequent renewal, it becomes a matter of economy to provide reasonable facilities for the reproduction of these tools, and also to fix the methods which shall be adopted for the use of the tools, so as to insure their utmost effectiveness and durability, and restrict within the narrowest limits the expenses of profitless manufacture. On drop work, for instance, it is to be determined what sized drop shall be used, and how many blows shall be struck at each operation. Drop dies, therefore, come well within the scope of the rule. They are quite expensive in both material and workmanship, and are often subjected to the handling of piece-workmen, who are naturally a good deal more interested in getting all they can out of them, in the shortest possible time, than they are in their preservation. It is true that drop-hammer men soon become shrewd enough, as a general thing, to know that, the better care they take of their dies, the easier and more freely they will work; but, as they stand with a piece of work in the die, which is not quite filled out with the blows already struck upon it, there is but an instant afforded them in which to decide whether it is best to give the cooling piece one blow more without reheating, and in that critical moment they are liable to be overcome by a surge of self-interest, and decide to hit it again and risk the die."

The ways in which dies may be injured in use are indicated. "A hot piece of iron might lie loosely in the impression of a die till it cooled. It could become cold without heating the corners around the impression enough to seriously affect their temper; but it is quite a different thing when the hot iron has already been struck with such force as to bring it into more intimate contact with the steel of the die than its own grains have with each other; for the steel has the heat absolutely forced into it when an additional blow is given. If this will not draw the temper, nothing will, and, if the corner of the impression is already almost red-hot, then the additional blow, driving down on the almost cold fin, will drive the corner and make it overhang and hug the work so that it will be hard to disengage it from the die. Then the good hammer-man, if he is not unmindful of the future, will have the die fixed before it gets any worse; but, if his temper rises when that of the die falls, he will continue to devil with the die until his work sticks so bad that, in removing it, it gets out of shape so much as to damage it. Then he will have the die repaired."

Mr. Spalding thinks that, notwithstanding some objections to heavy drops which he names, it is, as a general rule, better to use a force sufficient to press the hot metal into all parts of the die at one blow, especially in cases where "the especial economy of the dies" is a ruling consideration; but the striking of more than one blow improves the forging. When, then, the highest obtainable quality in the forging is the ruling motive, it is better to use lighter blows and repeat them till the hot metal fills the die. As a rule, however, stock can now be obtained that will give good forgings, whether forged by one or more blows, so that the improvement of the stock in the process of drop-forging is almost eliminated from modern practice.

A caution against unquestioning reliance upon "fair outsides" in judging the quality of drop-forgings is given. A very poor forging may look very well as it comes from the dies, but, notwithstanding, may contain cold shuts and imperfections. If drop-forgings do not possess desired qualities of strength, etc., "some revision should be made of the processes, and such corrections made as may have a favorable effect." When welding is to be done in dies, it should be done at a single blow. If more blows are used, there is danger of imperfections in the weld. Any part that does not weld at the first blow will scarcely unite by repetition of blows.

"If the dies are properly devised and the work is carefully manipulated, the material in a drop-forging can be brought to the highest degree of excellence which stock is capable of possessing. The stock can be wrought in drop dies to its greatest perfection without much injury to the dies. Stock allowed to cool from a welding heat, with no work done upon it below that heat, is very far from being in its best condition."

Soundness of Castings.

MR VON RIET has adopted the plan of fixing a separating chamber above the flask. This chamber is divided into three circular compartments. The molten metal is poured into the largest in such a way as to give it a whirling motion, which causes the heavy metal to keep to the sides, whilst the lighter scoria remains in the centre. A communication to the second compartment is made at one side, and here a further separation is effected, the purified metal escaping finally into the third compartment, in the middle of which is the pouring hole to the flask. In this way sounder castings are obtained.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

The Machine Shop.

31813. Working Stock in Drop Dies. B. F. Spalding (Am Mach–May 16.) 2000 w.

32142. Another Remarkable Broaching Job—A Limit Gage for Worm Threads. Ill. (Am Mach-May 30.) 900 w.

Steam Engineering.

31244. Hints on Boiler Inspection. Charles H. Garlick (Sta Eng–April.) 1200 w.

31711. Burning Coal Economically. With Special Reference to Small Sizes of Anthracite. (Extracts) Eckley B. Coxe (Bos Jour Com–May 11.) 2400 w.

31712. Superheated Steam—Some Remarks Concerning Its Economy (Bos Jour Com–May 11.) 1200 w.

31815. Setting Corliss Valves. Ill. (Am Mach–May 16.) 1800 w.

31846. The Smoke Question. Editorial (Am Mfr & Ir Wld–May 17.) 700 w.

31885. Hints about Injectors for the Engineer and Fireman. Ill. Anon. (Tradesman–May 15.) 1200 w.

31889. Auxiliary Stopping Devices for Steam Engines.—The Great Value They Would Be to Steam Users. E. C. M. (Bos Jour Com–May 18.) 1800 w.

31890. Pipe Coverings—A Test of Their Efficiency (Bos Jour Com–May 18.) 1000 w.

31945. Feed Water Heating. W. H. Booth (Am Mach–May 23.) 1400 w.

*32007. The Willans Engine. Report of paper by Mark Robinson (*Engng*–May 17.) 3300 w.

32105. A Gravity Return System for Utilizing Water of Condensation. Ill. Safety V–May 15.) 1700 w.

*32202. Steam Engine Problems. Editorial (*Eng*–May 24.) 1400 w.

32212—$1.25. The Determination of the Dryness of Steam. Ill. W. Cawthorne Unwin, with Discussion (Jour Am Soc Nav Eng–May,) 9800 w.

32250. Wastes from Boiler Management. R. C. Carpenter (Mach–June.) 2000 w.

32251. Boiler Heating Surface. Conrad Skarstedt (Mach–June.) 1000 w.

32267. Steam Jackets and Superheating (Bos Jour Com–June 1.) 2000 w.

32286. A Remarkable Engine. Ill. Designed by Thomas Hall and C. H. Treat (Power–June.) 3800 w.

*32386. The "Stephenson" Link Motion. Ill. G. R. B. (*Mech Wld*–May 31.) 800 w.

Miscellany.

*31630. New Methods of Connection for Power Transmission. Ill. E. Hoegerstaedt (*Mech Wld*–May 3.) 700 w.

*31650. The Gigantic Wheel (*Engng*–May 3.) 1200 w.

†31671. Furnace Draught. From Indian Textile Journal (*Ind & East Eng*–April 6) 1100 w.

*31694. Belt and Rope Transmission Trials (*Elect'n*–May 3.) 3300 w.

31705 Safety Valves. W. G. Blackgrove (Can Eng–May.) 1700 w.

*31771. Process of Manufacturing Leather Belting. Ill. (Milling–April.) 1000 w.

31799. Graduations for the New Decimal Gauge. Oberlin Smith (Ir Age–May 16) 2000 w.

31804. A Recent Supreme Court Patent Decision—Ridson Locomotive Works vs. Medart (Elec Wrld–May 18.) 4000 w.

31809. Bessemer, the Inventor, and his Treatment by the Britishers. From Boston Commercial Bulletin (Sci Am–May 18.) 1600 w.

*31817. Belting (*Mech Wrld*–May 10.) 1700 w.

31832. The Friction of Wood upon Wood at High Pressures. Ill. Edwin A. Messiter and Richard C. Hanson (Eng News–May 16.) 1500 w.

*31833. Eli Whitney: A Shakespeare of Invention (Self Culture–May.) 3000 w.

31839. Review of paper by W. H. Pfahler on "Foundry Costs" (Ir Tr Rev–May 16.) 1800 w.

*31873. The Economics of Coal. Editorial (*Engng*–May 10.) 2500 w.

31888. Machinery and Labor.—Methods of Investigation of Its Effects by the Labor Department (Bos Jour Com–May 18.) 700 w.

*31903. Fuel Testing Stations. E. G. Constantine (*Prac Eng*–May 10.) 1000 w.

31933. Density Affected by Compression. B. F. Spalding (Age of Steel–May 18.) 700 w.

31954. Brake Test of Gas Engines at Danbury, Conn. Anson W. Burchard (Ir Age-May 23.) 2300 w.

*31956. Test of a 500 H. P. Triple Expansion Engine. S. G. Colt and J. B. Mitchell (Sib Jour Eng-May.) 1500 w.

31974. Half a Century of Cycles. Ill. From the London Daily Graphic (Sci Am Sup-May 25.) 3300 w.

*32017. Coal-Unloading Arrangements by Savon Freres, Marseilles. Ill. (*Col Guard*-May 17.) 1500 w.

*32028. Patching Up Defects. G. C. Henning, in Cassier's Magazine (*Ir & Coal Tr Rev*-May 17.) 2500 w.

*32030. The Second Law of Thermodynamics. Oliver J. Lodge (*Elect'n*-May 17.) 6000 w.

32081. Various Uses of Compressed Air (Age of St-May 25.) 800 w.

†32090. Modern Calorimeters and Their Use. Ill. Joseph Struthers (School of Mines Quar-April.) 5500 w.

32106. Trial of a Schmidt Motor (Boiler Superheater and Compound Engine.) M. Schroter. Summarized by Bryan Donkin (Safety V-May 15.) 3000 w.

32179. Aboriginal Handicraft in Stone. Gerard Fowke (Archæologist-June.) 3400 w.

32231. Mechanical Forces. C. R. Tompkins (Age of St-June 1.) 1500 w.

*32257. Ball Bearings. Ill. W. H. Booth (*Prac Eng*-May 24.) 2200 w.

32287. Riveted Joints. C. W. Mac Cord (Power-June.) 1800 w.

32308. A New Air Compressor. Ill. (Eng News-June 6) 1100 w.

*32354. Power Generated by Gas Engines Working with Producer Gas and Distributed Electrically.—Summary of a Report by Captain Leneveu (*Col Guard*-May 31.) 1900 w.

*32359. Furnace for the Rational Burning of Coal and Coke Dust and the Residue of Coal-Washing (*Col Guard*-May 31.) 1100 w.

†32394. The Manufacture of Insulated Wire. John E. McGregor (Ind Rub Wld-June 10.) 1000 w.

32398. Comparitive Cost of Electricity and Compressed Air for the Transmission of Power to Long Distances. Herman Haupt. 8000 w.

Serials

13033. Practical Hints to Boilermakers and Templaters. Ill. (*Mech Wld*-Began May 12, 1893—18 parts to date—30 cts. each).

13534. The Gas Engine (*Mech Wld*-Began June 2, 1893—15 parts to date—30 cts. each).

16781. Rope Driving. J. J. Flather (Elec Wld-Began Oct. 26, 1893—19 parts to date—15 cts. each).

17823. Designing Corliss Gears. Ill. James Dunlop (*Prac Eng*-Began Nov. 24, 1893—11 parts to date—30 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (*Elect'n*-Began Dec. 1, 1893—35 parts to date—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (*Elec*-Began Aug. 31, 1894—19 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Theodore F. Scheffler, Jr. (Mach—Began Oct., 1894—9 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. R. Gordon Blaine (*Mech Wld*-Began Dec. 7, 1894—9 parts to date—30 cts. each).

30216. Care and Maintenance of Machinery. "Quirk" (Tradesman-Began March 15—6 parts to date—15 cts. each).

30555. The Proportions and Movements of Slide Valves. W. D. Wansbrough (*Mech Wld*-Began March 22—4 parts to date—30 cts. each).

30875. Fuel Oil. Comparative Results in Steam Generation. Clayton O. Billow (Elec Engng-Began April—2 parts to date—15 cts. each).

30971. Gas Power in the American Market. Ill. (Pro Age—Began April 15—4 parts to date—15 cts. each).

31095. Method of Initial Condensation and Heat Waste in Steam-Engine Cylinders. R. H. Thurston (*Ind & Ir*-Began April 12--Ended April 26—3 parts—30 cts. each).

31380. The Birth and Commercial Development of the Gas Engine. James Schleicher (Pro Age-Began May 1—Ended June 1—3 parts—15 cts. each)

31413. Old Master Mechanics. Extracts from a Lecture by John Richards (Ind'y-Began May—2 parts to date—30 cts. each).

31652. The Development of the Experimental Study of Heat Engines. W C. Unwin (*Engng*-Began May 3—Ended May 10--2 parts—30 cts. each).

31655. The United States Naval Gun Factory at Washington, D. C. Ill. (*Eng*-Began May 3—Ended May 10—2 parts—30 cts. each).

31763. Thermo-Dynamics. W. C. Popplewell (*Prac Eng*-Began May 3—3 parts to date--30 cts. each).

31944. The Shops of W. F. and John Barnes. Ill. John Randol (Am Mach-Began May 23—3 parts to date—15 cts. each).

31946. Cheap Fuel. Eckley B Coxe (Am Mach-Began May 23—Ended May 30—2 parts—15 cts. each).

32143. Grinding with Emery and Corundum Wheels. C. H. Norton (Am Mach-Began May 30—2 parts to date—15 cts. each)

32260. Riveted Water Pipe in the United States. Harold Jeans (*Eng Rev*-Began May 20—1 part to date—30 cts).

32328. Some Thoughts on Machine Design. De Volson Wood (Am Mach-Began June 6—1 part to date—15 cts).

32390. Modern Economy in Steam Engines. W. Arnold (*Prac Eng*-Began May 31—1 part to date—30 cts).

Third Report of the Alloys Research Committee.

An elaborate series of experiments on the composition and behavior of alloys has been conducted by the alloys research committee of the British Institution of Mechanical Engineers, and the latest results and conclusions are now given out as a third report by the chairman, Prof. W. C. Roberts-Austen, the well-known metallurgical authority. The investigation has gone into details of refinement which cannot be indicated here, and the reader is referred for precise information to the report itself, which is published in the *Iron and Coal Trades Review* (May 7) and *Industries and Iron* (May 3). The topics discussed in the present report are molecular porosity; increased sensitiveness of pyrometer; cooling curves of electro-iron, and of aluminum-copper alloys; iron-aluminum alloys; welding of iron and steel; anti-friction metals; etc.

Among the general conclusions reached are some regarding the strength of metals and alloys, which are of much interest. Prof. Roberts-Austen credits Pictet with having pointed out, in 1879, that there must be a connection between the melting points of metals and the periodic law of Mendeléef, since for all metals there is a simple relation between their atomic weight, the amplitude of their molecular vibrations under the influence of heat, and their melting-point. Pure metals with high melting-points — such as platinum, iron, copper, and gold—are comparatively strong; and conversely metals with low melting-points—zinc, lead, cadmium, bismuth, and tin—are relatively weak. Metals with high melting-points must necessarily be coherent and tenacious, because much *heat* is required to drive their molecules apart in reducing them to the liquid mobile state in which their molecules have little coherence; and therefore at ordinary temperatures much *force* must be applied to overcome the cohesion of the molecules and break the mass. Conversely in metals with low melting-points a small elevation of temperature will overcome the molecular cohesion and render them liquid. Such metals are weak, because, if little heat is required to melt them, less force will be required to tear them apart. Hence melting-point and tenacity are closely connected.

The experiments on the alloys of copper and tin and a series of cooling curves of the copper-nickel alloys support the view that there is an intimate connection between the melting-point of an alloy and its mechanical properties. This connection, which is well marked at ordinary temperatures, becomes of great importance in the case of alloys that have to be subjected to more or less heat in industrial use.

It is shown that the majority of alloys have more than one solidifying point, and it is necessary to ascertain which of these points is the important one in relation to mechanical properties. The presence of a trace of metals with a large atomic volume, and consequently low melting-point, renders the mass brittle and unfit for mechanical use. Weakness is here associated with the low subsidiary melting-point. The action, however, of traces of impurities on masses of pure metal is very different from the effect of two metals on each other when alloyed in more or less equal proportions. In the latter case the temperature of the main freezing-point appears to be the more significant factor. The problem is a complex one, but Prof. Roberts-Austen believes that the increased sensitiveness which has now been given the recording pyrometer renders its experimental solution more hopeful.

Sulphuric-Acid Making from Gold Ores.

A plan which has long been discussed, but which, we believe, has not hitherto been put into successful operation,—namely, the utilization of the sulphurous gases formed in roasting gold-bearing pyrites for making sulphuric acid,—is about to be tried on a commercial scale at Blacksburg, S. C. The pyrites used in existing sulphuric-acid works in this country can hardly be termed gold ores, though, like almost all pyrites, they sometimes contain traces of gold. A correspondent of the *Manufacturers' Record* furnishes a description of the works now being built at Blacksburg. He explains that the critical question is whether the gases, on leaving the roasting furnace, are rich enough in sulphur dioxid to be worth saving; that is, not requiring an extravagant condensation space and attendant expense. The usual roasting furnaces require a large excess of air for oxidizing; but he claims that a mechanical furnace has been devised (and will be used) to completely desulphurize the ore and at the same time leave the fumes in good condition for making acid. The gases are to be drawn from the furnaces through flues, in the ordinary manner, to the lead chambers, passing on their way through a niter oven supplied with sodium nitrate and sulphuric acid, the resulting gases intermingling and passing to the chambers, where they come in contact with steam, in accordance with the usual reaction process. Hecker and Gilchrist pipe columns will be used in connection with the chambers, by which a large reduction of space and expense is expected to be secured. There will be four chambers, with a capacity of 90,000 cu. ft., and six of these columns, with coke tower and all latest improvements. The plant will handle 10 tons of pyrite concentrates per charge. The acid is to be run by gravity to a fertilizer plant, there to be used in making acid phosphate.

The Crystallization of Steel.

THE animated agitation of the old question whether iron and steel, by repeated jarring and stresses, become "crystallized," and thus change from the fibrous or compact structure to one admitting of fracture under strains far below those sustained by the same metal in tests before service, is not at an end yet. Now the *Railroad Gazette* makes a suggestion that will clear the subject of one source of confusion of ideas,—the use of a term which in itself implies the explanation of breakages at abnormally low stresses. It proposes to get rid of one stumbling-block by dropping the word "crystallization" when speaking of metals broken in service (for this is a matter of degree only, from the minute crystallization detected only under the microscope up to the coarse granular or macrocrystalline structure), and substituting "fatigued" or something else more descriptive of the fact. The *Gazette's* idea is not a mere evasion of the question, but is intended to eliminate a snap explanation. It does not in any way discourage the most thorough investigation of all the physical properties of metals as examined in test pieces and again after rupture. More thorough study of facts and less theorizing are evidently needed.

The "Indicator" Feature in Some Gold Occurrences.

IN the famous Ballarat gold field of Victoria, Australia, the course of mining in early times followed the same lines as in the same period and later in other gold districts,— beginning with the surface placer, or "alluvial" (as it is locally called), and afterward extending to the working of veins. In time it was noticed that a class of stringy, irregularly-shaped quartz occurrences in soft slates meant greater richness in the "alluvial," and, when the shallow alluvial became worked out, the miners turned their attention to the quartz in place. After they had reached a depth where the country was less oxidized, the quartz occurrences in a certain band of slates and sandstones were found to be associated with a pyritic sheet (varying in thickness from 1-8 in. to about 1 in.), in the neighborhood of which, and also in the pyritic seam itself, were found the richest concentrations of gold. This pyritic seam became known as "the indicator." Subsequently a number of similar seams of pyrite, having more or less connection with the best gold ground, were found in the district, and were given characteristic names.

Mr. William Bradford, of Ballarat, has lately communicated to the Australasian

Institute of Mining Engineers a paper describing "the indicator" and its congeners. As to their origin, the author says: "To my mind the 'indicator' quartz formations appear to be due to the same class of causation as was instrumental in forming the larger quartz occurrences known ordinarily as lodes. . . These 'indicators' are in most cases mineral segregations in main fissures." The principal minerals of the "indicators" are pyrites, galena, and blende, and "it appears as if the most favorable situations for the deposition of [free] gold are the most favorable for the deposition of the iron, lead, and zinc; and all minerals are apt to take the slightest excuse in the form of a ledge, or pocket, or floor of any kind, for their deposition." Mr. Bradford cites a few of the many well-known occurrences of a similar nature, where, instead of being in a wide, defined lode with plain walls, gold is found in and associated with thin stringers of pyritic minerals; and he proceeds to extend the observations into a generalization, saying: "Since it appears that the 'indicator' feature of gold and quartz occurrences is due to the fissuring of certain parts of the mineralized strata, I have no doubt that it is present, and in the form in which we know it, in all quartz-mining fields all the world over." That is a rather sweeping assertion, and is not borne out by the facts so far as observation goes, for there is an indefinite variety of segregated deposits. But there is a good deal in the author's conclusion that "as miners we have been devoting too much attention to 'big main lodes.' Experience teaches; and I have no doubt that the stringy, spur-like formations of quartz, especially where associated with pyrites veins ('indicators'), will receive more attention."

Alteration of Coal Due to Subsidence at a French Colliery.

In May last a sudden disruption of strata, amounting to a small earthquake, occurred at the Montrambert colliery, Loire, France, producing an unusual crushing effect upon the coal. The phenomenon is described by M. E. Coste in the *Annales des Mines*, and a translation of his paper appears in the *Colliery Guardian* (May 3). It seems that the working area is about 2200 ft. long, and the seam, which is quite regular, averages about 5 ft. at one end and 3 ft. 6 in. at the other. Immediately above the coal is a thin false roof of shale impregnated with coal, varying in thickness, but not exceeding 20 in., and filling the inequalities of the true roof, which is a thick bed of solid sandstone. On the floor is another, but thinner, bed of sandstone, and between it and the coal is a false floor of clayey sandstone of variable thickness,—taking the place of the typical fireclay. The stalls had been carefully packed, but the roads leading to them were not fully gobbed. Loud detonations have been sometimes heard, tolerably rare as the lower portion of each panel is being worked, but becoming more frequent as the working advances. In 1888 a sudden displacement occurred to either the roof or floor of the seam, causing a shock that was felt for a considerable distance. The noises recently heard were attributed to the fracture of the floor, and they often corresponded with shocks sufficient to throw down the props. On May 5, 1895, a very severe shock occurred, cracking the timbers and accompanied with a violent rush of air. Fortunately nearly all of the miners were out of the workings at the time, but most of the lights of the few men in the roads were blown out, and the men thrown about. Inspection showed that the roof and floor were much nearer together than before, the false roof having fallen in, and in places the roads were blocked and the stalls nearly filled. In the disturbed area all the cleavage planes of the coal were opened, and the coal was so tender that a mere touch brought it down, and a thick cloud of dust was formed, which had not been the case before. A small bed of very fine coal dust was found next the floor, which did not previously exist. Everywhere the coal was found to be in a crushed state and very friable. The commotion was felt at the surface.

The author concludes by observing that, if similar fractures of roof or floor can cause such serious effects in a non-fiery mine, they might provoke far-reaching accidents in those where firedamp is present. A sudden disengagement of all the gas from the crushed coal would take place, and also that contained in the goal and in fissures in the roof and floor would be liberated, while the rush of current would prove a severe trial to most safety-lamps. It might be added that the dust formed in the disturbance would add a further dangerous feature.

The Mines of Nevada.

ACCORDING to "Dan de Quille," who writes to the *Mining and Scientific Press* (May 11), the mining industry of Nevada is now narrowed down to the working of gold properties,—gold-bearing quartz veins and the few scattered placers. "No mines are now being worked for silver alone; it will not pay to mine silver at present anywhere in Nevada at its price as a commodity. . . . Here and there bonanzas are found that are so rich that for a time silver can be so cheaply mined that profit can be made at 60 cents an ounce; but count all the work done on the veins of the district, county, or State, and it will be found that every ounce of silver obtained has cost from $1.30 to $1.50. It is the same of gold mining. When a man is so fortunate as to hit upon a big deposit of rich ore near the surface, he is often able to take out gold at a cost of from $3 to $5 an ounce, or even less. But these rich pockets in gold veins and the bonanzas in silver veins are few and far between." This pessimistic view of precious-metal mining is based upon the principle of general averages, the prizes being few and the failures many. It does not, however, detract from the success of this kind of mining in those cases which (leaving aside mere strokes of blind luck) rest on known premises and have the advantage of good management. "All gold-bearing veins, great and small, are being examined and prospected, and the placers are being raked over and worked in the best manner possible, most of them being in regions that are almost or quite valueless." The camp mentioned as now the most promising in the State is Silver Star district, in Esmeralda county. Silver Peak, Hawthorne, and Pine Nut are also favorably noticed. "The leading mines of the Comstock are holding out well,"—that is (a point not stated by the author), by depending upon their gold output and treating the silver as a by-product. These mines, popularly supposed to be purely silver producers, have, in the course of their history, turned out over a third of their values in gold, rating the silver at full coinage value ($1.29 per ounce); while of course at present the relative importance of the gold is much greater than formerly.

Proximate Composition of Steel.

IN the *Engineering and Mining Journal* (May 11) Mr. H. M. Howe discusses the results obtained by Prof. Ledebur and published in *Stahl und Eisen*, and incidentally refers to the work of Cheever, Barrows, and Turner. Mr. Howe says: "In order to discover how the different elements are combined with each other in metallic iron, to learn which is combined with which, and according to what formulas,—in short, in order to determine the proximate composition of the metal,—we naturally seek first to remove the great mass of iron itself which separates and dilutes the small quantities of these compounds existing within it, so that we may concentrate and isolate them in a measure, and thus examine them at greater advantage." Of the two most promising ways of doing this, (1) by dissolving the iron away with solvents so weak that they do not affect the compounds initially present, and (2) volatilizing the iron in a stream of chlorine, he says that here, as in so many other cases, methods full of promise and apparently simple on examination are found full of pitfalls, and that we must be sure that the very act of removing the iron does not change the constitution of the compounds which we seek to study. Mr. Howe, examining the chlorine method, points out the inherent difficulties, particularly the oxidation of phosphids to phosphates, etc., the oxygen being derived from entangled iron oxid and perhaps from sand. While Ledebur's results establish little firmly, they should be welcomed, Mr. Howe thinks, both as a warning of the difficulties involved, and to incite other analysts to devise and follow new methods of studying this very important question.

A Bromo-Cyanid Process.

A PROCESS for the extraction of gold from ores, tailings, slimes, and concentrates, which is proposed by Dr. C. A. Mulholland, of Bathurst, N. S. W., is described by the inventor in the *Australian Mining Standard.* The method is untrammeled by patent rights. It has not yet passed the experimental stage, though satisfactory tests are reported. It differs from the Sulman-Vautin process in that free bromine is used, in connection with potassium cyanid, and not a cyanogen-bromid. The process is based upon the ability of bromine to displace cyanogen from its compounds in the presence of a metal,—to form a double cyanid of the metal and a bromate. The object of adding bromine to the cyanid solution is to liberate cyanogen in a nascent condition, in which state the author claims that it is a much more effective solvent for gold. If an excess of bromine is added, it is stated that potassium bromid and hydrocyanic acid are formed; but that loss of the acid may be prevented by adding alkali. The claim is made that the new process will economize the quantity of cyanid; that the action of the solvent is very rapid; and that the percentage of gold recovered is higher. As to the last point, a saving of 97 per cent. of the gold in slimes is reported; but laboratory tests of this kind are always very unreliable. Another claim is that the bromine may be recovered, after precipitation of gold by zinc (as in the ordinary process), by concentrating the solution by evaporation and treating with hydrochloric acid. This of course would be impracticable on the working scale. It is proposed to use the bromine either (1) by successive small additions while the ore is kept agitated; (2) allowing the cyanid solution to percolate in the presence of bromine vapor; or (3) by blowing air and bromine in suitable proportions through the ore in the leaching solution.

New Mexico's Gold Camps.

A GOLD-MINING region which is attracting considerable attention at present comprises three camps (La Belle, Anchor, and Midnight) in the Sangre de Cristo range, in Taos county, N. M. A correspondent of the Denver *Mining Review* furnishes an account of the history and existing condition of these gold fields, which, though considered new, were known so far back as the '60s, but not systematically prospected until 1893. La Belle is on the Costilla grant, owned chiefly by Dutch capitalists, and the land company has inaugurated a new system of establishing titles to mining ground by deeding the claims after the usual location, filing of notice, and staking, and compliance with the forms of the United States mining laws, the business being transacted direct with the land company instead of through the usual official channels,—the total expense per claim being about $156.

The whole mineral belt is about 20 miles in extent. The surface ores are oxidized, tending to run into sulphurets in depth, but so far are free-milling. The development work consists of numerous small tunnels and short shafts, showing, besides the oxidized ores, black iron ore carrying free gold and also traces of tellurids. There is an abundance of water and timber. La Belle is at an altitude of 9200 ft. above sea-level. A branch railroad is projected to reach the district from the U. P., D. & G. road. A number of mines and prospects are described by the correspondent, who reports rich specimens, but the general average of the ores does not appear to be very high, after making the usual deductions from what is claimed by the owners.

Utilization of Blast-Furnace Cinder.

IN the *Iron Age* Mr. S. Norton, who has made this subject a study for a number of years and has largely experimented in this direction, expresses the opinion that, at least for furnaces making foundry pig, the cinder can be made a source of profit. The question of making use of what has always been a loss, he says, is well worth the attention of managers "who expect to stay in the business." Summarizing the results so far obtained, he names first among the valuable by-products the so-called "mineral wool" or "slag wool." This has already a large market, and at the present prices the cinder sold as mineral wool would amount, according to Mr. Norton, to more than the sales of pig iron made during the same time. All that is necessary is a reverberatory so built that the molten cinder, as it comes from the blast furnace in the ladle car, can be dumped into the reverberatory; and with a small fire and the admixture of clay or sand it can be brought to the proper state and blown. The wool is used, like asbestos, as a covering for steam-pipes and boilers, for a wall filling for ice-houses, etc. Granulated in water, the cinder makes a sort of hydraulic cement. The wool, ground with a small proportion of slaked lime, becomes a plaster, like alabastine and similar compounds. The cinder can also be run into bricks, either solid or hollow. Past failures to make a good paving-brick, Mr. Norton says, were due to guess-work methods, and he explains how a solid, glasslike brick can be made. The large dumps of old cinder could be utilized for road-making, and, if ground, could be used in place of lime fertilizers on clayey lands.

The Largest Gold Nuggets.

It is a peculiarity of American gold mines that large nuggets are extremely rare; in fact, the greatest mines seldom show any gold whatever visible to the eye. Very valuable pockets containing large quantities of small gold have been often met with, both in placers and quartz mines; but solid nuggets of good size are infrequent. The great nuggets come from Australia—and not always or usually from the most important mines. A correspondent of the *Mining and Scientific Press* furnishes an interesting list of the famous Australian nuggets, as recorded in the colonial government reports. The largest piece of gold ever found in the world was taken from the Byer & Haltman claim, Hill End, New South Wales, May 10, 1872, its weight being 640 lbs.; height, 4 ft. 9 in.; width, 3 ft. 2 in.; average thickness, 4 in.; value, $148,800. Next on the list come the Oates & Delson, $50,000; Welcome Stranger, $45 000; Welcome, $44,366; Leg of Mutton, $32,380. Following these are several valued at from $10,000 to $30,000. The California list contains one nugget from Carson Hill, Calaveras county, worth $42,000. Several large masses of quartz and gold from California are on record (which, however, are not true nuggets). Among them are one lump from Downieville, Siena county, worth nearly $90,000, and one from the Bonanza mine, Tuolumne county, yielding over $40,000. The writer of this notice has seen the contents of one pocket in a Colorado mine, consisting of large lumps of quartz, clay, and gold, worth altogether about $60,000, taken from a claim which on the whole was not extraordinarily productive.

Tinplate of South Wales.

A VIVID picture of the present depressed condition of the Welsh tinplate industry is presented by Mr. A. Howells, United States consul at Cardiff, an abstract of whose report appears in the *Bulletin* of the American Iron and Steel Association (May 10). Until recently South Wales enjoyed a monopoly of the tinplate trade, and the United States have always been, and still remain, the greatest customer. Since the establishment of American tinplate works, there has been a considerable falling-off in the American demand without any compensating call from other markets. The difference has been an entire loss to the Welsh manufacturers, few of whom appear to be interested in the new works on American soil. The year 1894 is described as "a wretched one," and the present outlook is by no means hopeful. As to the effect of the reduced tariff of the Wilson bill, the consul quotes from an English paper the statement that "the American works, which, it was thought, would have to stop, are going on as vigorously as ever. . . . Their position has actually improved recently, inasmuch as they have obtained a reduction in wages of about 30 per cent., while in Wales the strong effort made in the same direction has up to the present proved futile, excepting in a few isolated cases." To show the serious decline in tinplate exports the following figures are given:

	1892.	1893.	1894.
To the United States	[illegible]	[illegible]	[illegible]
Total exports,	[illegible]	[illegible]	[illegible]

THE *Ironworkers' Journal* reports that the result of the accountants' examination of the returns of the sales of manufactured iron, by the firms associated with the board of conciliation and arbitration for the manufactured iron and steel trade of the North of England, shows a net selling price of £4 14s. 10.66d. per ton average, with the result that there is no change in the wages of the men under the sliding scale agreement. The wages, therefore, for June and July will be the same as for April and May. The weight invoiced, upon which the returns were based, amounted to nearly 18,000 tons. The journal compliments Sir David Dale, the referee of the board, upon his well-earned honor of a baronetcy, just conferred upon him in recognition of his services. In reality this is the first time that an honor has been conferred for purely industrial work and in recognition of services in connection with arbitration in labor disputes.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Metallurgy.

31636. Ledebur on the Proximate Constitution of Steel. Henry M. Howe (Eng & Min Jour–May 11.) 10000 w.

*31699. The Elimination of Impurities During the Process of Making "Best Selected" Copper. Allan Gibb (*Ind & Ir*–May 3.) 2000 w.

*31740. Third Report to the Alloys Research Committee. W. C. Roberts-Austen (*Ir & Coal Tr Rev*–May 3.) 5000 w.

*31743. Recent Improvements in American Metallurgy. Mr. Douglas' Second Lecture (*Min Jour*–May 4.) 3300 w.

31747. The Tin-Plate Trade of South Wales. Anthony Howells (Bul Ir & St As–May 10.) 1000 w.

31748. I. The Latest Carnegie Armor Plate Test. II. Last Test of Bethlehem Armor Plate (Bul Ir & St As–May 10.) 1200 w.

*31753. The Art of Casting Bronze in Japan. Ill. W. Gowland, with Discussion (*Jour Soc of Arts*–May 3.) 20000 w.

†31774. The Volumetric Determination of Zinc and a New Indicator for Ferrocyanide. George C. Stone (Jour Am Chem Soc–June.) 1300 w.

*31784. The Golden Bar Milling Plant, Coolgardie (W. A.). W. A. Robertson, in the Goldfield's Courier (*Aust Min Stand*–March 23.) 1100 w.

*31792. A Bromo Cyanide Process.—Improved Method of Treating Auriferous Ores, etc. C. A. Mulholland (*Aust Min Stand*–April 13.) 1000 w.

31840. How to Get Smooth Castings. W. Hales (Ir Tr Rev–May 16.) 600 w.

31849. Cyaniding or Chlorination? E. A. Schneider (Eng & Min Jour–May 18.) 800 w.

*31864. The Reduction of the Rarer Metals from Their Oxides. W. C. Roberts Austen, with Discussion (*Jour Soc of Arts*–May 10.) 4000 w.

*31895. Metal Mixers. Arthur Cooper, with Discussion (*Ir & Coal Tr Rev*–May 10. 3800 w.

*31907. Recent Improvements in American Metallurgy. Mr. Douglas' Third Lecture (*Min Jour*–May 11.) 3200 w.

*31919. The Effect of Arsenic on Steel. John Edward Stead (*Ir & St Tr Jour*–May 11.) 8000 w.

31939. Some Mechanical and Electrical Features of the Carnegie Steel Company's Building, Pittsburg, Pa. Ill. Henry Floy (Elec Eng–May 22.) 2800 w

31964. Ramming. Ill. H. Hansen (Foundry–May.) 2800 w.

*31966. Ternary Alloys of Iron with Chromium, Molybdenum, and Tungsten. James S. De Benneville (*Ironmonger*–May 11.) 11900 w.

31991. The Golden Bar Dry-Crushing and Cyanide Plant, Coolgardie (Eng & Min Jour–May 25.) 900 w.

31994. Structural Adjustments for Expansion and Contraction. Editorial (Eng Rec–May 25.) 1000 w.

*32008. Effects of Temperature on the Strength of Wrought Iron. Editorial (*Engng*–May 17.) 1500 w.

*32013. Recent Improvements in American Metallurgy. Fourth and Last Lecture of James Douglas (*Min Jour*–May 18.) 2500 w.

*32021. A Twenty-five Years' Retrospect of the Iron and Steel Industries. Ill. (*Ir & Coal Tr Rev*–May 17.) 4500 w.

*32024. Modern Methods of Chemical Analysis of Iron and Steel. Anon. (*Ir & Coal Tr Rev*–May 17.) 3300 w.

*32025. Desulphurizing in the Basic Open Hearth. E. H. Saniter (*Ir & Coal Tr Rev*–May 17.) 900 w.

†32049. Crystallization or Fatigue. F. E. R. (*Ind Eng*-April 27.) 2500 w.

32126. The Manufacture of Face Hardened Armor. Extract from paper by A. A. Ackerman (Ir Age-May 30.) 3600 w.

32138. Tin-Plate Manufacture in Austria (Am Mfr & Ir Wld-May 31.) 2000 w.

*32172. The Dressing and Metallurgical Treatment of Nickel Ores. Ill. A. G. Charleton (*Jour Soc Arts*-May 24.) 30000 w.

*32176. The Treatment of Pyritous Concentrates by Cyanide. A. F. Crosse (*Min Jour*-May 25.) 1500 w.

*32178. Determining Chromium in Chrome Ores. Edmund Clark (*Chem Tr Jour*-May 25.) 1200 w.

32187. The Elimination of Impurities During the Process of Making "Best Selected" Copper. E. D. Peters, Jr. (Eng & Min Jour-June 1.) 1800 w.

*32197. A New Form of Calcining Kiln for Ironstone. (Abstract.) Charles Wood (*Col Guard*-May 24.) 2500 w.

*32387. Castings and Patterns (*Mech Wld*-May 31.) 1100 w.

Mining.

31637. The White Cliffs Opal Fields, New South Wales. F. G. de V. Gipps (Eng & Min Jour-May 11.) 1500 w.

31638. The Mining Industry of Bolivia (Eng & Min Jour-May 11.) 2000 w.

*31654. Coal Washing Plant, Powell Duffryn Company's Elliott Pits. Ill. (*Eng*-May 3.) 1600 w.

*31657. Alteration of Coal Due to Subsidence at the Montrombert Colliery, Loire, France. Ill. (*Col Guard*-May 3.) 1000 w.

*31658. The Coal Mines Regulation Bill, 1895.—Report of Thomas Ratcliffe Ellis (*Col Guard*-May 3.) 9400 w.

31696. New Mexico's Great Gold Camp. Ill. Dean Burgess (Min Rev-May 10.) 2300 w.

*31742. The Road to Coolgardie. Brenton Symons (*Min Jour*-May 4.) 1800 w.

*31745. Mining Captains. Editorial (*Min Jour*-May 4.) 1200 w.

*31785. The Kapanza Mine, Coromandel (N. Z.)—Deep Level Work (*Aust Min Stand*-March 23.) 1000 w.

*31786. Underground Haulage. A. Gardiner (*Aust Min Stand*-March 30.) 2300 w.

*31789. The "Indicator" Feature in Some Gold Occurrences. William Bradford (*Aust Min Stand*-April 6.) 2300 w.

31822. The Mines of Nevada. Dan de Quille (Min & Sci Pr-May 11.) 800 w.

31848. Coal Mining in the Transvaal, South Africa (Eng & Min Jour-May 18.) 800 w.

*31867. Observations on the Coal Mines Regulation Bill, 1895. Thomas Ratcliffe Ellis (*Col Guard*-May 10.) 9000 w.

*31876. Marble and Granite in Georgia. Ill. (Stone-May.) 8500 w.

31883. Electricity or Compressed Air in Mining. J. H. Piper (Tradesman-May 15.) 6400 w.

*31910. Coolgardie. Brenton Symons (*Min Jour*-May 11.) 3200 w.

*31965. The Mines of Elba. Herbert Scott (*Ironmonger*-May 11.) 7500 w.

31977. The Oro Blanca Country. Don C. Pickett (Min & Sci Pr-May 18.) 1000 w.

31990. Mexican Taxes on Gold and Silver, with Editorial (Eng & Min Jour-May 25.) 1500 w.

*31998. The Coal Fields of Northern Europe (*Bd of Tr Jour*-May.) 900 w.

*32012. The Londonderry Mine. Brenton Symons (*Min Jour*-May 18.) 1300 w.

†3 092. The Sinking of the Ladd Shafts. Ill. George S Rice (School of Mines Quar-April.) 5000 w.

32112. The Gold Belt of Calfornia. H. W. Turner (Sci Am Sup-June 1.) 3500 w.

33185. Metalliferous Mining in New Zealand. John Plummer (Eng & Min Jour-June 1.) 700 w.

32186. Electric Haulage at the Berwind-White Company's Eureka No. 22 Colliery. Timothy W. Sprague (Eng & Min Jour-June 1.) 2000 w.

*32195. New Regulations as to Mine Explosives in Germany (*Col Guard*-May 24.) 2200 w.

*32196. Structure of the Belgian Coalfield. F. Cambessedès (*Col Guard*-May 24.) 3300 w.

*32199. Half-a-Century of French Coal Production and Consumption (*Col Guard*-May 24.) 1100 w.

*32203. Rateau Fans at the Lens Colliery. Ill. (*Eng*-May 24.) 2000 w.

*32243. The Russian Petroleum Industry (*Fairplay*-May 24.) 1100 w.

32298. The Mining Industry of Bolivia. From Report of British Consul (Sci Am Sup-June 8.) 1800 w.

32300. Further Notes on the Gold Ores of California. H. W. Turner (Min & Sci Pr-June 1.) 2200 w.

32333. Gunpowder and Nitroglycerine. W. Hodgson Ellis (Can Min Rev-May.) 1400 w.

*32355. Blown-Out Shots. James Ashworth (*Col Guard*-May 31.) 1700 w.

*32356. Safety in Mining. (Abstract.) W. N. Atkinson (*Col Guard*-May 31.) 3400 w.

*32357. Report of Her Majesty's Inspectors of Explosives (*Col Guard*-May 31.) 7500 w.

*32358. Use of Electricity in Mines. Ill. Translated from La Revue Technique (*Col Guard*-May 31.) 3300 w.

*32367. Mine Gases.—Their Analyses by Absorption, by Means of the Hempel Apparatus. Baird Halberstadt (Col Eng-June.) 2000 w.

*32368. Sulphur Mining.—A Description of the Sulphur Mine at Davis, Mass. E. McCormick (Col Eng-June.) 1200 w.

*32392. Certain Dissimilar Occurrences of Gold-Bearing Quartz. Ill. T. A. Rickard, with Discussion (*Min Jour*-June 1.) 6000 w.

Miscellany.

31847. The "Flouring" and "Sickening" of Mercury. T. A. Rickard (Eng & Min Jour-May 18.) 1100 w.

*31868. Unloading British Coal at a Foreign Port, with Tables of Comparative Heat Values. M. J. Buser (*Col Guard*-May 10.) 1400 w.

*31878. Compressed Air Power as Applied to Quarry Work. From Catalogue of the Ingersoll-Sergeant Drill Co. (Stone-May.) 4000 w.

*31894. Presidential Address of Mr. David Dale (*Ir & Coal Tr Rev*-May 10.) 9500 w.

*32022. The Iron Trade Situation at Home and Abroad. Anon. (*Ir & Coal Tr Rev*-May 17.) 2000 w.

*32177. The Electric Lighting of Mines. Editorial (*Min Jour*-May 25.) 1800 w.

32180. Coal Washing—Notes on Its Progress in the South (Tradesman-June 1.) 2000 w.

32183. Manufacture of Cement from Blast-Furnace Slag. Editorial on Article by Hermann Crueger (Eng & Min Jour-June 1.) 900 w.

32184. Mineral and Metal Production of the United States in 1893 and 1894 (Eng & Min Jour-June 1.) 1400 w.

*32194. The Mint—Past and Present. Joseph Newton (*Ill Car & Build*-May 24.) 2300 w.

*32198. Continental Competition in the Iron and Steel Industries. Extracts from report of William Jacks and J. S. Jeans (*Col Guard*-May 24.) 3800 w.

*32232. The Rise of the Scotch Steel Industry (*Ir and Coal Tr Rev*-May 24.) 3500 w.

*32237. Algerian Alabaster (*Arch*-May 24.) 1800 w.

*32369. Riedler Pumps and Air Compressors. (Col Eng-June.) 1300 w.

Serials.

20413. Mining Methods. Ill. (Col Eng-Began March, 1894—16 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (Col Eng-Began March, 1894—16 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (Col Eng-Began March, 1894—16 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (Col Eng-Began March, 1894—16 parts to date—30 cts. each).

22710. Science for Ironmongers. By a Member of the Royal Institution (*Ironmonger*-Began June 2, 1894—19 parts to date—30 cts. each).

27329. Coal-Mining Economy Up to Date (*Ir & Coal Tr Rev*-Began Nov. 23, 1894—14 parts to date—30 cts. each).

29468. The Cyanide Process—Its Practical Application and Economical Results. A. Scheidel (*Min Jour*-Began Feb. 9—Ended May 18—14 parts—30 cts. each).

30047. Prospecting—Where and How to Find Gold and Silver Deposits. Ill. Arthur Lakes (Col Eng-Began March—4 parts to date—30 cts. each).

30049 Mine Surveying—Latest American Ideas and Most Improved Practice. Edward B. Durham (Col Eng-Began March—4 parts to date—30 cts. each.

30214. Coke Making. Ill. William Bowron (Tradesman-Began March 15—4 parts to date—15 cts. each).

30461. The History of Iron. Notes from Dr. Ludwig Beck (Ir Age-Began March 28—6 parts to date—15 cts. each).

30912. The Glasgow Iron and Steel Company's Works, Wishaw. Ill. (*Engng*-Began April 5—3 parts to date—30 cts. each).

31330. Colliery Surface Works. Edward Brownsfield Wain (*Col Guard*-Began April 19—Ended May 10—4 parts—30 cts. each).

31459. Is the Use of Cyanide of Potassium for Gold Extraction Common Property? E. Andreoli (Eng & Min Jour-Began May 4—2 parts to date—15 cts. each).

31504. Modern Foundry Practice. Ill. (*Engng*-Began April 26—2 parts to date—30 cts. each).

31511. The Tin-Plate Industry in the United States (*Eng*-Began April 26—Ended May 31—5 parts—30 cts. each).

31709. The Rarer Metals and Their Alloys. Ill. W. C. Roberts-Austen (*Nature*-Began May 2—2 parts to date—30 cts. each).

31744. Mining and Milling at the Mesquital del Oro Gold Mine, State of Zacatecas, Mexico. Arthur C. Claudet (*Min Jour*-Began May 4—1 part to date—30 cts).

31783. Tin-Mining in Northern Queensland. John Munday (*Aust Min Stand*-Began March 23—Ended March 30—2 parts—30 cts. each).

31788. Chromite Mining in the Gundagai and Tumut Districts (N. S. W.) Joseph E. Crane (*Aust Min Stand*-Began March 30—Ended April 6—2 parts—30 cts. each).

31790. Hydraulic Gold-Sluicing on the West Coast of Tasmania (*Aust Min Stand*-Began April 6—2 parts to date—30 cts. each).

31793. The Commercial Use of Minerals. Norman Danvers Power (*Aust Min Stand*-Began April 13—1 part to date—30 cts).

31908. Victorian Gold Mining. Thomas Cornish (*Min Jour*-Began May 11—4 parts to date—30 cts. each).

31909. Deep Level Mining on the Rand. Editorial (*Min Jour*-Began May 11—Ended May 18—2 parts—30 cts. each).

32020. Cyanide Practice.—Report of paper by Alfred James (*Eng*-Began May 17—Ended May 24—2 parts—30 cts. each).

32027. Early Recollections of the Iron Trade. Anon. (*Ir & Coal Tr Rev*-Began May 17—1 part to date—30 cts).

Rapid-Transit Problems.

THE relation of the adopted rapid-transit lines to the other means of communication in New York city is the subject of a letter by Mr. Fr. von Emperger, addressed to *Engineering Record*, which, together with two small diagrams, occupied five columns of the issue of that paper for May 11. There is much in this letter to merit consideration from New Yorkers, and to call out the editorial comments bestowed upon it in the same issue; and there are points also made that are worth considering in all large cities contemplating the construction of rapid-transit roads. The points of merely local interest here in New York we shall not review, confining our notice to what is of more general import, both in the letter and in the editorial called out by it. In our opinion the most noteworthy point is the stress laid upon the wisdom of making haste slowly in developing any engineering scheme of such weighty influence upon the future welfare of a city as a system (properly so-called) of rapid communication between all its principal parts, and over the principal directions in which the daily tide of population ebbs and flows. A mistake at the outset may adversely affect the growth and prosperity of a city for all time.

Mr. Emperger calls attention to the fact that all the large cities, both here and in Europe, have had to grapple with the question of rapid transit. Though many of the problems connected with it are local for any particular city, there are some that are general in their application. Thus the author regards "the slow progress made by the New York Rapid Transit Commission," as the least thing to blame them for, "because any final decision they have yet arrived at has such far-reaching consequences to the whole life of the city for generations" that "he prefers to call them slow" rather than "to see them do some irreparable damage." We must "get rid of the narrow-minded idea that we have only to provide for the present need, and get up to some far-looking point of view."

"It is clear that the value of a line from an investor's point of view and from that of the public cannot be the same, because for the one a certain expense in the construction requires a corresponding number of passengers, while for the public a line keeps its value, and the cost of construction may be high or low. It may be in the public interest to build a road only for the benefit of certain surroundings. . . . Even enterprising private capitalists have done this, but there was then backing up by the real-estate interest, or by the government. The latter way is usual in Europe. It does not mean, as is often heard these days, 'that the city pays $50,000,000.' It only means that the government has investigated the question, and found it safe for private investment, and in doing so it backs up its opinion by saying: 'In case we are wrong, we will pay the interest.'"

"The routes adopted for rapid transit should be main communications and connect with all the present routes." These routes "should be considered as main arteries, of which the other companies are the feeders."

The plans adopted by the New York commission are elaborately criticised with reference to existing local roads. This criticism is, however, pervaded throughout with a spirit of fairness. The opinion that "it is faulty engineering to propose engineering structures without considering all their details in advance," and that "the purposes for which they are built should receive the most careful attention," is one that applies to all municipal work, and, in fact, broadly in all departments of engineering. The opinion that "neither a good plan nor the desirable improvements of traffic can be obtained without municipal control" is expressed; but the author does not favor municipal ownership in this country.

Editorially, *Engineering Record* deprecates, the "importance" given by "portions of the public press" . . . . to the apparently slow progress made by the New York Rapid Transit Commission, and thinks such impatience will not be shared by engineers, who, "at least, will appreciate the gravity of the problem and the difficulties which attend its solution." A wholesome doubt as to the advisability of intrusting American municipalities with the expenditure of large sums in such enterprises is indicated in the closing paragraph of the editorial.

"There is a great deal to be said on both sides of the question of involving the credit of the city of New York to a greater extent than $50,000,000, and we do not propose to enter upon any attempt to show whether it would be wise or unwise to do so. It is perhaps Utopian to look forward to the time when the city government could be trusted to enter upon an expenditure so great for the benefit of all its citizens; and yet, until that time comes, no municipal government will have attained to a condition in which either efficiency or economy can play its full part. Although past experience with the New York city government may be taken to demonstrate the unwisdom of such a procedure as entrusting to it the expenditure of so great a sum as that just named in connection with rapid-transit lines, it is doubtless true that that amount of money judiciously and honestly expended for genuine rapid-transit facilities in New York city would be one of the best possible investments for its present and ultimate benefit that could possibly be devised. In such a case, however, it would not necessarily follow that some part of such an expenditure should not be applied to the perfecting of present facilities."

Interference of Frost in Gas Manufacture.

A PAPER read by Mr. William Hardie before the North of England Gas Managers' Association (*The Gas World*, May 4) portrays some of the difficulties experienced from frost by English gas-works during the past winter. These difficulties culminated in the early part of February, at which time the frost was more severe and continuous than at any previous time for 30 years, and the damage done to gas- and water-mains is stated to be entirely without precedent.

An important point made in this paper is that much of the inconvenience experienced with scrubbers and washers may probably be avoided "by laying off a portion of the condensers so as not to cool the gas excessively." This plan was pursued at Tynemouth with very satisfactory results, the gas inducted to the scrubbers never being at a temperature below 60° F. The steam and water pipes at these works are wrapped with straw rope, and encased in boxes filled with sawdust. The purifiers are "fitted with hydraulic valves, and are supplied from tanks at one end of the house, through 3-in. and 4-in. pipes. The water in the leading supply-pipes was kept circulating by running a small quantity off at the end farthest from the supply-tanks," and a little steam was allowed to flow into the water near the tanks. A little steam was also allowed to flow into the purifier lutes, as occasion seemed to demand.

A curious experience with a purifier during the frost period is recounted. "This purifier had been filled with lime that had been prepared 2 or 3 days previously, and was not put to work for about 48 hours after being filled, when it was found that the gas would not pass through it. Means were taken to make sure that the valves and pipes were quite clear, after which it was decided that the severe frost acting on the moisture in the lime had caked it into a more or less solid mass. The gas was then forced through at a high-pressure,—the difference between the inlet and outlet of the purifier being about 12 in. water pressure,—and steam from a ¾-in. pipe was allowed to play upon the inlet pipe. The heat caused by the steam and by the chemical action of the impurities of the gas upon the lime caused it gradually to come to its normal condition; and in about 3 hours the gas was passing through with a difference in pressure of about 1 in."

Temporary steam-pipes were also used for keeping the water from freezing in the gas-holders. As indicating the severity of the frost, an instance of the freezing of the water in one gas-holder is cited, requiring the use of coke fires for thawing it out. It is recommended to use a portable boiler in gas-works, not only to keep the gas-holders right in frosty weather, but for many other purposes in and around gas-works. It was, however, in the distributing systems that the gas manufacturers experienced the greatest embarrassment. Broken mains and stoppages occurred nearly everywhere. There were ten times as many complaints from consumers as were received in the previous year. The stoppages were not entirely due to frozen water, but partly to deposits of hydrocarbons of the benzine and naphthalene series that occur at the freezing temperature of water. If, however, water vapor be not present in the gas, these latter deposits do not occur, and no stoppage either by ice or hydrocarbons can occur.

"The usual methods adopted to remove these obstructions is to pour salt and boiling water down the service, and then use the air force-pump to drive it into the main pipe. With the lamp services we generally use a steel wire down the pipes before employing the force-pump. Occasionally, using the force-pump blocks the service so hard that it can only be cleared by lifting the ground; but this is, forfunately, a rare occurrence. We have also used a non-freezing composition for removing the lamp stoppages, which our workmen consider assists them very much."

In the discussion elicited by this paper it was brought out that steam-engines have been largely superseded by gas-engines in gas-works, which emphasizes the importance of keeping a portable boiler at hand for ready use, as suggested by Mr. Hardie. In response to a request for an explanation of the reason why gas-mains break in frosty weather, Mr. Hardie said he thought they "were really broken by the frost, and that probably the reason was that the ground was so hard bound that the contraction which took place could not get free vent, as it would under ordinary circumstances when the ground was more pliable." He thought there was no doubt that during a severe frost pipes were broken. With regard to the temperature of the gas, he thought it was bad practice to reduce it to a lower point than he had mentioned,—about 60° F. There was no doubt that at many places people had suffered very much in the washers and scrubbers, and had had them thrown out of action for some very considerable time. He could not conceive that this could occur otherwise than by having gas going into them at too low a temperature.

Sewer Outlets in Sliding Banks.

THE banks of Lake Erie at Cleveland are bluffs 50 to 70 ft. above the shore line. The drainage of the city issues from the mouths of the sewers at the shore line, and, to prevent the frequent sliding of the banks from interfering with the maintenance of the sewer outlets, a kind of construction differing from that usually employed has been necessitated. This construction is described in *The Engineering Record* (May 18) with illustrations, showing the geological character of the banks and the method employed for repairing sewers broken by these slides, one of which broke off 150 ft. of the sewer, threatening the undermining of adjacent buildings.

"The top of the bluff to a depth of 10 to 14 ft. is a bed of sand and gravel, underlaid by a stratum of sand and clay, which rests in turn on a deposit of blue marly clay. The last is described as principally fine sand, and nearly enough clay to cement it, and a sufficient quantity of lime to give it a marly character. In a wet state the material has somewhat the character of quicksand, although compact sand and hard when dry. Before protective measures were adopted, there had been a general encroachment of the lake at Cleveland amounting to 205 ft. in a period of 46 years. In some instances the slides have caused piling 50 to 75 ft. from the shore to rise up several feet with the upward heave of the bottom, the latest slide crowding the older ones before it."

"The conditions favorable to a landslide are as follows: First, as this clay has very little tenacity in a dry state, the foot of the slope is rapidly dissolved and washed away by the waves at such times.

Second, the material cracks under the summer heat, and during wet weather the sand and gravel layer overlaying the sand becomes saturated with water, which seeps out in many springs along the face of the bank, follows the crevasses, and assists to lubricate the unstable mass. Therefore any permanent work of construction on such a bank must contemplate the cutting-off and diversion of the surface water by drains reaching down to the clay, and also the protection of the foot of the bank by jetties or otherwise. The old method of construction has been to carry brick construction close to the water's edge, where a massive stone outlet was built, no effort being made to preserve the bank. The consequence of a slide was usually a sheared sewer and a washout."

The plans adopted for repairs of existing outlets, and for the prevention of their injury by sliding of the banks, "provided for a riveted steel sewer 5 ft. in diameter supported on 35-ft. white-oak piles 12 in. in middle diameter and 8½ ft. apart. Crosspieces were gained into the piles to support the pipe, and waling strips were bolted on them at the top to give additional strength. The greatest difficulty was experienced in taking care of the water and in making a good joint between the steel pipe and the brick sewer. The former was laid from the lake inland, until there was a gap of about 5 ft. between it and the brickwork. After the joints were calked with lead, and the pipe thoroughly inspected, a specially-designed connecting piece was dropped into place, and a concrete foundation was built up around the joint for about 4 ft. on each side. The pipe was constructed of ⅜-in. tank steel in 30-ft. lengths and dipped in a bath of California asphalt after being previously heated to a temperature of 300° F. About 1½ ft. of clay puddle was packed around the pipe carefully for its entire length, so as to protect it from any water which might seep through the refilling, largely composed of cinders from the plant of the United States Salt Company. A 6-in. drain tile was run along the bank near the main sewer to cut off the ground water as far as possible. The trench was then refilled for a depth of 4ft. with sand and gravel properly tamped." The grade of the sewer is uniform,—64 per cent. The steel pipe is made of two sections each 30 ft. long, one of 25-ft. and one of 5 ft., and it connects with a box 60 ft. in length. This box is sustained by piles with 10″ × 10″ cross-caps 9 ft. long. The junction of the pipe with the box is a flange, riveted to a plate which is bolted to the sides and bottom of the box. The cost of repairs is stated to have been about $5500.

Gas Enrichment.

In his address before the North of England Gas Managers' Association at its April meeting (*Journal of Gas Lighting*, April 30), the president, Col. Sadler, spoke of gas enrichment as the absorbing question of the hour in the gas industry. "The continuous cry from gas consumers for more light, and the never-ceasing efforts of gas-makers to produce still cheaper gas, compel the latter to tax every resource within their power to accomplish these widely-divergent ends,—*viz.*, higher illuminating power without seriously increasing the cost. Cheaper coal, and less gas taken off, will do it, of course. But the first is not always available, and the second not often convenient. A larger yield of gas per ton of coal and the enrichment of its low illuminating power naturally suggests itself to everyone as the readiest solution of the problem."

Neither oil or carburetted water-gas will ever seriously come into competition with coal-gas where there is an exhaustible supply of good gas coal. The sudden and unexpected advance in the prices of mineral oils places carburetted water or oil-gas out of the running at the present. The long period of unprofitable returns in the oil trade makes it improbable that there will be an early return to the low prices lately prevailing.

The incandescent burner has gone so far in "settling the question of more light independently of the candle-power" that the speaker thought nothing more would need to be said about the matter, had it not also been discovered that a rich gas is both better and more economical with the mantle burner. "Good gas will be wanted, notwithstanding the general adoption of the incandescent light; and benzol is the best and cheapest, as well as the most natural, enricher of coal-gas. It requires some courage to say this after the brilliant and classic researches of Professor Lewes on acetylene, which shot athwart the sky of the gas world like a dazzling meteor, paling for the time all our poor attempts at illumination."

"I have been asked to say a few words about acetylene. Well, it is a malodorous gas, which all here will have often observed when ordinary gas is burned with insufficient air, as happens when a Bunsen burner is lit at the bottom, or has lit-back, as is often the case with cookers and gas-stoves. It is a very posionous gas; and, owing to its ready tendency to polymerize, —*i. e.*, form molecules of hydrocarbons, either multiples of itself or (by deposition of carbon and other rearrangements of its atoms) hydrocarbons of more complex structure,—it explodes with the slightest detonation."

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Gas Supply.

*31680. The Frost and the Gas. W. Hardie, Jr. (*Gas Wld*–May 4.) 2500 w.

31697. A Graphic Discourse on Some of the Compounds of Illuminating Gas. A. W. Wilkinson (Am Gas Lgt Jour–May 13.) 1700 w.

*31706. The Determination of Sulphuretted Hydrogen and Other Impurities in Coal Gas. J. T. Sheard (*Jour Gas Lgt*–April 30.) 900 w.

*31707. On a Property of the Non-Luminous Atmospheric Gas Flame.—Report of paper by Lewis T. Wright (*Jour Gas Lgt*–April 30.) 1700 w.

*31708. Notes on Gas Enrichment.—Presidential Address of Col. Sadler, with Discussion (*Jour Gas Lgt*–April 30.) 6000 w.

31768. Upon the Determination of Tar in Gases. Ill. W. Leybold (Pro Age–May 15.) 1800 w.

*31796. Inaugural Address of F. G. Dexter (*Jour Gas Lgt*–May 7.) 7200 w.

31845. Means of Using Incandescent Gas Lamps Out of Doors. Ill. (Am Mfr & Ir Wld–May 17.) 600 w.

*31930. The Work of the Photometric Standard Committee. Vivian B. Lewes (*Gas Wld*–May 11.) 6000 w.

*31931. The Modern Gas Engine: Its Development and Application. G. E. Stevenson (*Gas Wld*–May 11.) 5700 w.

*31932. Report of the Standards of Light Committee (*Gas Wld*–May 11.) 1600 w.

*31981. Presidential Address of C. C. Carpenter (*Jour Gas Lgt*–May 14.) 4500 w.

*31982. On the Temperatures Employed in the Distillation of Coal. Lewis T. Wright (*Jour Gas Lgt*–May 14.) 3800 w.

*31983. Dibdin's Ten-Candle Pentane Argand Air-Gas Standard. Ill. (*Jour Gas Lgt*–May 14.) 700 w.

*32044. The Work of the Photometric Standards Committee.—Discussion of paper by Vivian B. Lewes (*Gas Wld*–May 18.) 5000 w.

*32045. The Modern Gas Engine: Its Development and Application. Discussion of paper by G. E. Stevenson (*Gas Wld*–May 18.) 2500 w.

32309. How We Made Acetylene. By One of Them (W Elec–June 8.) 1000 w.

*32046. Acetylene and Its Enrichment Value. Vivian B. Lewes, with Discussion (*Gas Wld*–May 18.) 5400 w.

32067. Incandescent Gas Lighting. S. M. Highlands, with Discussion (Am Gas Lgt Jour–May 27.) 8500 w.

32068. Metal Gasholder Tanks. Allen S. Miller, with Discussion (Am Gas Lgt Jour–May 27) 3700 w.

32069. Advantage of the Metric System for All Calculations. George H. Harper, with Discussion (Am Gas Lgt Jour–May 27.) 4500 w.

32075. Natural Gas as a Pioneer for Artificial Fuel Gas. Donald McDonald (Am Mfr & Ir Wld–May 24.) 2500 w.

*32129. Discussion on Lewis T. Wright's Paper on "The Temperatures Employed in the Distillation of Coal" (*Jour Gas Lgt*–May 21.) 1600 w.

*32130. Installation of Carburetted Water Gas at Tottenham. A. E. Broadberry, with Discussion (*Jour Gas Lgt*–May 21.) 7500 w.

*32131. Sloping Retorts. J. Husband (*Jour Gas Lgt*–May 21.) 3000 w.

32139. Acetylene. F. L. Slocum (Am Mfr & Ir Wld–May 31.) 2000 w.

32155. Experience with Foul Gas. James T. Linn, with Discussion (Pro Age–June 1.) 3300 w.

32157. Variations in Temperature in the Interior of Gas Holders. W. Leybold (Pro Age–June 1.) 1800 w.

*32236. The Monier System of Cement Construction as Applied to Gas Works. F. D. Marshall, with Discussion (*Gas Wld*–May 25.) 4800 w.

32265. Recuperative Furnaces as Applied to Bench Firing; Their Operation and Results. J. A. Faux, with Discussion (Am Gas Lgt Jour–June 3.) 2500 w.

32266. Ammoniacal Liquor; with a Special

Reference to the Universal Saving of the Same by Gas Companies. George Osius (Am Gas Lgt Jour–June 3.) 3000 w.

*32345. Discussion of J. Husband's Paper on "Sloping Retorts" (*Jour Gas Lgt*–May 28.) 4300 w.

*32346. The Manufacture of Sulphuric Acid by Sulphate of Ammonia Makers. Fletcher W. Stevenson, with Discussion (*Jour Gas Lgt*–May 28.) 5400 w.

*32347. Purified Ammoniacal Liquor aud Its Uses in Gas Purification. T. Holgate, with Discussion (*Jour Gas Lgt*–May 28.) 2800 w.

*32349. Gas Works Construction. A. Drage, with Discussion (*Jour Gas Lgt*–May 28.) 6800 w.

Sewerage.

31722. Metropolitan Sewerage Works, Boston, 1894. Ill. (Eng Rec–May 11.) 3500 w.

31841. Sewer Outlets in Sliding Banks, Cleveland, O. Ill. (Eng Rec–May 18.)800 w.

31995. The Drainage of New Orleans. Ill. (Eng Rec–May 25.) 5000 w.

†32283. Pneumatic System for Small Sewage Works. William Fairley (San–June.) 900 w.

Streets and Pavements.

31830. The International Street Sweeping Machine. Ill. (Eng News–May 16.) 900 w.

31843. Paving Brick, from the Standpoint of the Engineer and Manufacturer. Daniel W. Mead (Eng Rec–May 18.) 3000 w.

*31900. Street Subways for Large Towns. Charles Mason (*Arch*–May 10.) 3600 w.

32109. The Clean Streets of Rome. From the New York Sun (Sci Amer–June 1.) 1200 w.

*32224. America's Vitrified Brick Pavements. Ill. William Pierson Judson (Paving–June.) 2500 w.

*32225. Street Sanitation. W. F. McNutt (Paving–June.) 700 w.

*32227. Kinds of Stone Suitable for Road-Making. Clemens Herschel (Paving–June.) 300 w.

Water Supply.

31634. A Six-Foot Windmill for Domestic Water Supply. Ill. (Met Worker–May 11.) 800 w.

31968. The New Water Supply of Atlanta. Ill. Joel Mable (Eng News–May 23.) 800 w.

31969. New Stand Pipe at St. Bernard, O. Ill. George Hornung (Eng News–May 23.) 1400 w.

31973. Submerged Wooden Water-Works Intake Pipe, New Whatcom, Wash. C. M. Adams (Eng News–May 25.) 800 w.

32065. Pumping Water on the Ohio River (Fire & Water–May 28.) 1000 w.

†32093. The New Conduit of the Rochester Water Works. E. Kuichling (School of Mines Quar–April.) 15500 w.

32136. Should the Building of Stand-Pipes Be Abandoned? Editorial (Eng News–May 30.) 1700 w.

32137. Cost of Pumping Water for Cities, Towns and Villages. (Abstract.) Samuel G. Artingstall (Eng News–May 30.) 900 w.

32163. Gas and Oil Engines for Water Works Service in Germany. Translation of paper by Max Munzel (Eng Rec–June 1.) 3600 w.

32210—$1.25. Digest of the Experiments Made by Mr. Michael Longridge, Chief Engineer of "The Engine, Boiler, and Employers' Liability Insurance Company" of Manchester, England, on the Triple Expansion Pumping Engines at the East London Water Works, Lea Bridge and Described in His Report to the Company for 1893 (Jour Am Soc Nav Eng–May.) 22500 w.

*32348. The London Water Supply in the Past Year. From Report of Dr. Frankland (*Jour Gas Lgt*–May 28.) 2000 w.

Miscellany.

31723. The Relation of the Adopted Rapid Transit Lines to the Other Means of Communication in New York City. Fr. von Emperger, with Editorial (Eng Rec–May 11.) 5700 w.

*31749. Ideal Sanitation. (Extract.) B. W. Richardson (*Brit Arch*–May 3.) 1800 w.

31779.—$1. State Supervision for Cities. J. R. Commons (An Amer Acad–May.) 6000 w.

*31795. An American on British Municipal Government.—Review of Article by M. J. Francis, in The Engineering Magazine, and Work by Albert Shaw (*Jour Gas Lgt*–May 7.) 2000 w.

*32033. The Limits of Municipal Enterprise (*Builder*–May 18.) 1100 w.

*32089. Why Municipal Reform Is a Failure. Charles E. Burton (Am Mag of Civ–June.) 1500 w.

*32226. Municipal Engineering in Troy, N. Y. Ill. (Paving–June.) 3000 w.

32290. Street-trees (Gar & For–June 5.) 1500 w.

Serials.

5358. Sewage Purification in America. Ill. (Eng News–Began July 14, 1892—46 parts to date—15 cts. each).

14839. Water Purification in America. Ill. (Eng News–Began Aug. 3, 1893—17 parts to date—15 cts. each).

27603. A Treatise on the Construction of Railroad Rolling Stock. A Flamanche, A. Huberti, and A. Stevart (R R Car Jour–Began Dec., 1894—5 parts to date—15 cts. each).

30948. The New Rochester Water Works. Ill. (Eng Rec–Began April 13—Ended May 25—6 parts—15 cts. each).

31082. Water Supply and Pipe Distribution. Ill. F. C. Moore (Fire & Water–Began April 20—7 parts to date—15 cts. each).

31480. Sewerage in Foreign Cities. Edward Downes (San–Began May—2 parts to date—45 cts. each).

31701. Fires and Fire Engines in the Olden Times. William Perry (Can Eng–Began May—1 part to date—15 cts).

32223. Sanitary Engineering. William Paul Gerhard (Jour Fr Inst–Began June—1 part to date—45 cts).

RAILROADING

Western Railroad Construction.

MR. W. B. LAWSON contributed to the *Journal of the Association of Engineering Societies* for April a paper the primary purpose of which, as he declares, "is to place before the reader an outline sketch of the methods used in constructing our western railways, and something of the circumstances surrounding the builders; not to give theoretical instruction, or to tell an unknown tale. The author has been for some 25 years in the midst of the fray, both as a pawn and as a player in the game, and the statements made are such as his experience warrants.

"The lenses through which the critic views our railway systems and scans their details can never be of sufficient power to reveal the barbed environments which circumscribed the actions of the time; nor can present analysis reveal the value then placed upon fragments of time or upon small amounts of capital. To seize quickly the golden opportunity, and bind it with the slender means within quick grasp, lines with rich prizes at the yonder end were often cut. Uncaught fish are of little worth when the craft that floats us must be quickly handled or be wrecked. Yet a critic might declare: 'A sad mistake was made right there.'

"No one of our great systems is the result of a carefully pre-arranged plan, but rather that of welding together of numerous fragments, either ready made, or built as the plans developed and as seemed expedient to the management in temporary control; straight links and crooked links, hooked together as they lay,—'tis a wonder they are so good; 'tis a pity they are so bad. The rapid growth of plans, the whirl of events, and the tremendous energy displayed in wresting vast territories from wild nature, and from the other fellow, form a history of intense activity, which may be but outlined by the most masterly hand. The mainspring of all this energetic activity was private gain, a feverish desire that the reaper should keep pace with the sower, as well as an ambition to lead in the race."

The ease with which corporations may be formed for legitimate purposes, and the ease with which personal liability is therein avoided; the way in which advantage was taken of these facilities to further various interests by the organization of railway companies—little and big—prior to the era of railway consolidation; the aid afforded by States, counties, and municipalities to such enterprises; the introduction of useless grades and detours to secure local aids; and how all these, and other things, though open to criticism from an engineering point of view, helped development,—are all brought out in this paper.

"Strangely (?) the original settlers were wonderfully successful in selecting just the proper site for a railway station, and villages seldom dared to refuse the required bonus 'in compensation for the trouble incident to a station inconveniently located.' Local aids were pledged to grade and tie the road; the right of way and grade was pledged to iron and equip it. Railway stocks went with the bonds as a makeweight; the acquired land grant was appraised low; railway stocks were sometimes made legal tender for land; and the syndicate seldom happened to take the poorest lands in theirs. Thus sowers raced, and reapers trod their heels;—small wonder there was haste." The building of new lines "to sell to one or the other company, many of them in the line of progress, but others vicious blackmailing schemes," is spoken of,—the latter class as retarding progress.

"The larger extensions are now usually succored by some large corporation, or by individuals therein having sufficient influence to secure their adoption by the company in good time. This is usually done with great secrecy, shrewd strategy, and many denials. Local corporations of small pretensions are organized, by which contracts and deeds for right of way are taken, and for which locations of line are more or less perfected; local rivalries are skilfully stimulated; men of local influence are flattered by official places; communities and individuals are caressingly milked quite dry of rights of way and privileges; and sometimes monetary gifts are made, although the latter practice is becoming of ill repute. When the scheme is ripe, a new company is organized, into which all local companies are merged, from which the now useless dignitaries of local repute are excluded, and by which inconvenient pledges made by these dignitaries are often ignored. The child is adopted by the parent company, either openly, as one of the family, or covertly, as a poor relation on probation."

The struggle of rival companies is spoken of as "a war between giants, wherein treasure was poured out with a lavishness that sorely challenged the reputation for sagacity that some of our strongest men had won before, and which arms the anti-corporation howler with powerful weapons of attack. But the sketch of conditions of growth is sufficiently amplified to furnish, to stranger and to critic, the key to many riddles."

The duties of the chief engineer entail a burden of responsibility, but one in which he cannot always exercise his best judgment. His "judgment may be overruled arbitrarily by others, or by the force of circumstances; but such overruling leaves no trace of its action." He must be possessed of a rare combination of qualifications. "The quickly-formed mental estimate of cost is often strangely near the truth; the skill to make it is a faculty highly cultivated in some, and never acquired by a dullard. . . . It is not unusual for an imperative demand to come forth for an estimate to be completed within 2 or 3 days which, regularly calculated, would require as many weeks. 'A special meeting of financiers must consider the scheme at an early date,' or some such importunate circumstance seems always lying in wait to crowd the engineer. He must submit his best effort, upon which his reputation more or less depends, without show of hesitancy or discontent, or he incurs the odium of clogging the machinery by slow motion." Many of the most active locating engineers of former days spent years at the front, rarely meeting a fellow-craftsman or even seeing the work of other engineers; almost constantly remote from communication, and deprived of professional literature (aside from nature's volume and their own pocket note-book), with every day of their lives crowded with pressing duties. Brief calls upon their families, or from their wives, were the only comforts enjoyed during months of a life devoted to the stern demands of a calling arduous to the very extreme. . . . Many of the conditions met and conquered by force of original good sense and judgment were never met before, and still remain unrecorded. Much use of arbitrary formulas was made. A table used by many engineers in equating values of distance, curvature, and undulations is presented, followed by directions for its application to different conditions.

Passing interesting accounts of the organization and *personnel* of surveying parties; of the arduous duties and personal inconveniences of the locating engineer in field-work; of the rapidity with which constructive work follows that of location, of which the author says: "Location, construction, and finishing-grade stakes may all be urgently demanded of an engineer in a single day's work," and numerous complications caused by the necessity of avoiding publicity and various other influences; the method of defining right-of-way limits, acquisition of titles, and letting of contracts; the usual enterprise and skill of western contractors, often "better engineers than the men in charge"; the cost of various kinds of work, materials, and constructions, all of which are comprehensively treated in this exceedingly able paper, —we must close this review by quoting the eloquent language with which the paper concludes.

"From this outline of professional practice in the front ranks of scores of millions of struggling founders of a new civilization, preparing for them a way, do you gather that our ways are crude and our practice rude? They are not more so than the dictates of uncontrollable circumstances compel. Kid-gloves and hair-splitting niceties have been eliminated, 'tis true, but brains, untiring energy, and physical powers have won the race. In the mighty rush of events which constitutes our domestic history, the coming of the railway engineer has been the first omen of the incoming tides of people, the first signal that a new channel for the bounding pulses of a young athletic nation was to be carved. His indomitable energy has made easy of access boundless treasures of wealth, locked in solitude since time began. Before him traditional deserts have vanished and bountiful harvests have followed closely behind. From his footprints bright visions of fond hopes realized have ever blossomed. New-found homes for eager multitudes have sprung into beauty along his path, and eager thousands have quickly clustered around the centers which his keen foresight has first discerned and marked.

" Nor has his pace been slow? Eight times in a century would it tame a wilderness of the combined areas of Great Britain, Ireland, France, Switzerland, Austria, Prussia, Spain, Portugal, Italy, and Egypt. The swiftest denizens of our plains have been surrounded, and fields of grain have hidden the trail of the savage before he found a refuge. The restless wiry 'peg-sticker' of our times has been a 'potent simple' in the magical charm which has won the world's brightest land of promise from an obscurity as deep as time has been long. He has been here; he is gone, and is well-nigh forgotten; but Chicago and scores of fair cities and immense regions filled with homes of comfort bedeck his pioneer way."

The Practical Use of Transition Curves.

THIS subject has been recently brought to the fore by numerous discussions, and articles printed in papers devoted to railroading. An article by Mr. Walter Loring Webb, in *The Railroad Gazette*, (May 24), is one of the most useful practical contributions yet made to the general fund. It contains responses to a series of queries sent out to chief engineers of leading American railways, to ascertain the extent to which the utilization of "the numerous systems of transition curves that have been proposed" has been carried. The following were the questions propounded:

"(1) Do you use transition curves? (2) Do you follow any of the published systems (Searles, Crandall, Wellington, etc.)? If not, will you state briefly the mathematical character of the curve used? (3) What is the lower limit of curvature on which you consider the curves necessary? (4) What rule regulates the relation of length to degree of curve? (5) What methods are employed to enable trackmen to maintain the track at the true curve? (6) Have you discovered any uniform tendency for the track to shift laterally in any one part of the curve? Is there any difference in this respect (on double track) between transition curves running *on* the curve or running *off* the curve? (7) Do the trackmen take kindly to the system, and take an interest in keeping the alignment true, or do they consider it an impracticable, theoretical refinement?

" About three-fourths of the answers received reported the use of regular systems in the transition curves. Of the others some reported the occasional use in special cases. One such answer was from a road that is remarkable for its easy alignment, and on this account the necessity for transition curves has never been urgent."

Mr. Webb classifies the answers to the second question into "three general systems. The C., C., C. & St. L. uses the Holbrook spiral, a system based on the 'true transition curve,' in which the curvature varies exactly as the distance measured along the curve. The 'cubic parabola,' more or less modified, is the most common. It is used on the Philadelphia & Reading, L. S. & M. S., N. Y., N. H. & H., and C., B. & Q. Searles's spiral (a system of compounded curves, of equal length and regularly increasing degrees of curvature) is used on the Nor. Pac. and on the Union Pac. The So. Pac. and the Mich. Cent. use systems of their own, which are also a series of compound curves, but different in their details. The D., L. & W. uses the purely empirical method proposed by Trautwine in his book on railroad curves."

To the third question "the majority of answers gave 1°, 1° 30', and 2° as the lower limit. The Union Pac. uses spirals only on curves of 3° and over, and the Nor. Pac. on curves of 4° and over."

The answers to the fourth question show that from 50 to 300 ft. per degree of curve are used,—a very wide difference in practice.

Answers to the fifth question indicate that the difficulty in maintaining true curves has deterred "some roads from attempting transition curves at all, based on the argument that the track will very soon shift, and that nothing but an unreasonable demand on the engineering department will enable the trackmen to keep the track true. A few quotations on this point are significant. 'Track is laid originally to substantial track centers, which are easily found, if necessary, the centers being placed each 30 ft. on transition curves and each 50 ft. on main curves. Also, when originally ballasting, strong stakes are firmly driven to top of ballasted rail height, one stake 5 ft. each side of center, each 30 ft. on transition curves, and each 50 ft. on main curves. These stakes at once show any marked departure from true line, and they last for many years. When necessary, true line is retraced by transit and track relined, but it is not often required.' [So. Pac.] 'We set stakes—usually old angle bars driven 2½ ft. into the ground and marked on the top by a chisel mark—these stakes being set every 50 ft. Outside of our track we indicate the elevation to be given both at the beginning point of the spiral and at the place where the spiral and circular curve unite.' [C., C., C. & St. L.] 'We place monuments made of old rail at the points of curve and tangent of both the center curve and the easement curves, and we place intermediate stakes 50 ft. apart for the trackmen to line by as often as required.' [C., B. & Q.] The Philadelphia & Reading and also the N. Y., N. H. & H. use stone monuments placed at the beginning, center, and end of each elastic curve. Oak stakes, accurately centered, are placed at intermediate points. Nearly all the roads employing transition curves report the use of the above methods more or less modified."

As to the sixth question the "invariable answer" was that with transition curves the tendency to lateral shifting of track either in running on or running off curves is eliminated.

The answers to the seventh question are favorable to the maintenance of the curves; the trackmen find their total labor lightened, rather than increased, by a careful attention to the alignment.

Neither the Pennsylvania Railroad or the New York Central and Hudson River Railroad use transition curves, having apparently believed that they would be too difficult to maintain.

The Decline in Railway Charges.

THE great decrease in railway rates for transportation of merchandise; the tendency toward still further decrease, which railway managers would like to check, if they could, but which many of them believe is the "result of commercial laws which they have no power to restrain"; the necessity of devising further reductions without at the same time decreasing net revenue, on account of the "recent impetus which has been given to the construction of artificial waterways"; the governmental regulation of railways, and other points of vital interest to railroad men,—are discussed in *The Popular Science Monthly* for June, by Mr. H. T. Newcomb.

It was once maintained by men accepted as authority that wheat "would bear transportation only 250 miles to markets where it would bring $1.50 per bushel, and that the market for corn at 75 cts. per bushel must be within a radius of 150 miles from the point of production. To-day both of these products are carried from the great surplus-producing regions west of the Mississippi river and sold at much lower prices than those named, in order to supply the denser population located in the Eastern States and in Europe. Grain and flour are now carried from Chicago to New York over railway routes ranging from 912 to 1042 miles in length, for 20 cents per 100 lbs., or only about 4⅓ miles per ton per mile for the shorter distance."

Dry goods, such as calicoes, flannel, canvas, linen crash, ginghams, jeans, and sheetings, are taken from Boston to Vicksburg, Miss., about 1570 miles for 50 cts. per ton per mile. The rate on canned goods, including fish, fruits, meats, and vegetables, from San Francisco to St. Louis over rail lines from 2280 to 2950 miles in length, is 75 cts. per 100 lbs., or about 1-2 cent per ton per mile. The author explains that these examples are "selected at random, and without any intention of showing the lowest charges in existence, as will be clearly apparent when it is added that the average charge upon all freight traffic carried by rail during the year was only 0.866 cent per ton per mile." The decrease has, however, been very gradual. There have been some marked changes, as is proved by statistics compiled from the last annual report of the Inter-State Commerce Commission, but, on the whole, the progress has been slow and steady.

From these statistics it is seen that the average railway capitalization "has changed but little. Gross earnings per mile decreased during the first half of the period, but have remained without material change during the last; or, in other words, the increased traffic has so far balanced the decrease in charges that the average gross revenue has not changed. Operating expenses have increased during the last 11 years, though during the period from 1871 to 1882 they showed a decline. The explanation is that during the first period increased density of traffic permitted economies in conducting transportation which had the effect of reducing the average cost to the carriers. It would appear, however, that a point was reached beyond which the institution of new economies could not keep pace with increased traffic at low rates, and that this had its natural effect in the second period. This explanation gains force when the constant decrease in average net earnings per mile is noted. Average freight and passenger earnings are seen to have fallen off considerably since 1871, and the final effect of these changes is summarized by the item of dividends, which are seen to be less than 50 per cent. of those paid during 1871."

While "more than double the freight transportation of 1884 is now performed for a total compensation less than two-thirds greater, ... passenger transportation has increased 18 per cent. more than the prices paid therefor," and capital invested in stocks of 176,000 miles of railway property is now receiving a smaller total dividend than in 1884 it received from 125,000 miles. In answer to the inquiry as to whether rates will go still lower, it is said that, while some think they are too low, and others think they will still decline, the author thinks it "obvious that the return to capital invested in railway securities must not be further reduced," and that, if reduction of rates continues, economies not now practised will have to be practised. It is also evident that the author looks with complacency upon possible government ownership, in the belief that "our institutions will be found perfectly adequate to the new task," should this appear to be necessary to harmonize the operation of the consolidated properties with the public interest. Aside from this view, which we believe to be fallacious, the paper of Mr. Newcomb is a good contribution to the railway literature of the month.

Efficiency of Compound Locomotives.

A PAPER on this subject read by Mr. F. W. Dean before the American Society of Mechanical Engineers, at a recent meeting, is printed in full in *The Railroad Gazette* (May 17). In this paper the statement is made that the numerous inferior designs for compound locomotives that have been produced of late have tended to create a reaction toward locomotives of the pre-existing type. Notwithstanding that this reaction has resulted in the change of some compounds to simple engines, Mr. Dean asserts positively that the compound system is not discredited among progressive railroad men, and that "it is the greatest of all the economies that can be carried out on railways." The perpetuation and extension of the use of compound locomotives is predicted on the ground that there are a sufficient number now in use that are proving unobjectionable, and are "highly advantageous . . . . in many ways."

"There is nothing in which the expression 'survival of the fittest' will apply with more pertinence than to compound locomotives." Persons either possessing compound locomotives of the better class, or intimately acquainted with them, "never hesitate to say that they are the locomotives of the future, especially for freight, elevated-railroad, and suburban work. A type of engine that can clearly save fully one-quarter of the coal now used by simple locomotives; that materially reduces water consumption; diminishes boiler and slide-valve repairs; reduces smoke, cinders, and the fire risk; that steams better than the simple engines in hard places without a necessary increase of any kind of repairs, —must surely become the favorite as soon as people know which design to select."

The following are the reasons assigned for the asserted important saving of fuel. "(1) The steam can be more conveniently used with great expansion, and therefore high steam pressure can be more advantageously utilized. (2) Division of the expansion between two cylinders diminishes condensation to both cylinders by reducing the range of temperature in each cylinder. (3) Division of expansion between two cylinders renders it possible to evaporate, or re-heat, a portion of the moisture in the exhaust of the first cylinder, and thus render it capable of doing work in the second cylinder. As this can be done in the locomotive with waste gases, the gain is all profit. By using the proper kind of receiver, this is an effective means of economy. (4) Steam that leaks through the valve of the first cylinder is, in a properly-designed locomotive, worked expansively in the second cylinder. (5) Steam that is re-evaporated toward the end of the high-pressure piston stroke too late to work expansively, instead of being exhausted to the atmosphere, as in the simple locomotive, is worked expansively in the low-pressure cylinder."

Commenting and enlarging upon these propositions, the speaker said in substance, with reference to the first of them, that, while a short cut-off in a simple locomotive saves some fuel by lessening the effect of the exhaust on the draft, it is, at the same time, wasteful of steam. On the other hand, the compound locomotive saves 15 to 20 per cent. of the steam, and, above this, saves coal by its low terminal pressure in the exhaust.

As to the "fourth reason for economy," Mr. Dean stated that, "in some four-cylinder locomotives with a single valve to two of the cylinders, leakage may pass directly from the high-pressure cylinder, or even the boiler, to the atmosphere," so that this reason applies only to the two-cylinder compound.

Losses in compound locomotives are freely acknowledged; indeed, it was asserted that, in some compound locomotives, these losses have rendered them "more wasteful engines than simples." These losses arise from imperfections of the link-motion, which are strongly brought out in the high-pressure cylinder, from the large gap "between the bottom of the high-pressure and top of the low-pressure cards," and back pressure on the low-pressure piston.

"This discussion has brought out the fact that the compound locomotive is subject to losses to which the simple engine is not, and which may render it unfit for fast work. Such defects can, however, be fully overcome by large and easy passages, and the oft-repeated statement that the compound is fit only for freight trains is highly erroneous.

"From one point of view compound locomotives can be divided into classes,—*viz.*, the automatic, that starts by allowing live steam to pass to large cylinder only until the engine has made a half revolution, or thereabout; and non-automatic engines, that can be operated at will as simple locomotives as long as desired. I have always taken the position that the non-automatic engine does not allow the compound system to fully realize its object, and that the locomotive which does not immediately become a compound after making an initial movement is to some extent a failure. It is held by the advocates of this type that the automatic engine does not start well, and that it cannot pull a sufficiently heavy train over ruling grades. Neither of these features have come within my experience, although that has been with freight trains on a continuous grade of 96 ft. per mile, 12 miles long, and with heavy fast suburban passenger work, with eleven stops in 9 miles. It is no exaggeration, in fact, to say that the starting of the automatic engine has been uniformly surer than that of the simple engine in this service. The point here considered is of the greatest importance in suburban or elevated-railroad work, for here the compound is particularly economical, if it is a compound from the beginning. If it is a simple engine for some little time, the greatest part of its peculiar adaptation to the work which requires frequent starting is lost."

Considering another classification of compound engines into two,- three,- or four-cylinder engines, Mr. Dean said that "the four-cylinder compound cannot be justified from an economical standpoint, and has no reason for existence except as a means for producing a balanced engine." An elaborate comparison of the relative adaptability and advantages of the compound engines for different kinds of service completes the paper. In the discussion by members that followed the reading, many instances of the economy of the compound system on different railroads were cited.

Effect of Pooling Agreements Upon Commerce.

AT the opening of the Detroit chamber of commerce on May 2 Mr. Geo. R. Blanchard delivered an address in which he justified pooling, intimated that popular opinion upon it is largely based upon ignorance of its true nature, and stated that, although it has been regarded adversely, its effects upon commerce are beneficial rather than the contrary. Reviewing the effects of pooling, Mr. Blanchard, whose address is reported in *The Railway Age*, said that, "passing over its failures and minor defects," the chief error of the Inter-State Commerce act "was that it refused railways the right by enforceable contract to maintain reasonable rates (as the act itself required) through the only effectual means yet found in the commercial world,—namely, pools, traffic unity, or joint purses." As to the effects of non-pooling, the speaker said that, "after 8 years with the act, it is public knowledge that serious irregularities continue, benefiting mainly large shippers, who, plus yielding railways, compel conditions which injure smaller senders, and places, and well-intending carriers, beyond their powers of resistance or correction. Law does not create rectitude, and the main agency to correct wrongs practised by carriers or shippers or collusively must be the railways themselves; but the act gave them no helps to that end, only mandates and penalties. Nevertheless, the pendulum of more intelligent public experience, thought, and conviction now swings more equitably, and no great commercial measure (the amendment or repeal of the act) has ever secured more support from former opposers, as witness these proofs. In '93 the senate referred the subject to the Inter-State Commission for reconsideration, whereupon it asked commercial bodies and others as to the advisability of amending the act so as to legalizing 'pooling contracts which would tend to diminish unlawful discriminations.' Eighty-nine answers favored so doing, or the entire repeal of the act. In June, 1894, the conference of commercial interests and trade bodies held in Washington adopted the following resolution: '*Resolved*, that competing common carriers may safely be permitted to make lawful contracts with each other for the apportionment of their traffic, or the earnings therefrom, provided conditions and restrictions be imposed which protect the public from excessive and unreasonable charges.'"

Many competent authorities have approved the system of pooling. The speaker cited decisions of the New York court of appeals and of the supreme courts of Massachusetts and New Hampshire, and opinions of jurists and economists, to sustain this assertion; and added:

"I might stop here, and say that these many competent authorities have already studied and decided the commercial effects of pools; but, say our yet unconvinced friends: 'You ask congress to legalize trusts or combinations which will stifle competition and unduly advance rates.' And they inquire with triumphant logic: 'If railways do not intend these things, why do they desire pools?' Unlike trusts, we seek to extend, not curtail, reduction and facility, and we do not seek to enhance prices. Next, mark the clear distinction between reasonable rivalry and senseless strife; between stopping competition and regulating it; and between railway conditions and those affecting oil, corn, and iron."

The speaker quoted Prof. Hadley of Yale to the effect that there is but one alternative,—pooling or discrimination,—and added: "Answering the condition that we wish to advance rates, we desire to retain all legal sums which unchallenged fair tariffs, published as stipulated by law, require us to collect, thereby increasing our earnings by stopping preferential payments, needless reduced rates, unnecessary expenses. Moreover, if railways desired to advance rates unduly beyond proper tariffs, they could not do so more under pools than now. The rate-making power remains precisely the same." Further remarks citing illustrations of the benefits of pooling, among which the effects of the consolidation of the telegraph companies by the late Mr. Jay Gould were conspicuous, concluded the address, which was very favorably regarded.

Interstate Commerce Statistics.

THE following statistics are taken from the seventh annual report of the interstate commerce statician, for the year ending June 30, 1894. This report may be referred to again in this department. It arrived too late for fuller excerpts in this number. It appears to be a very able and carefully prepared document, containing a large fund of valuable information relating to American railways.

Miles of railroad completed........	178,708
Increase since June 3 , 1893, miles	2,247
Miles of track	233,533
Number of corporations............	1,954
Locomotives	35,492
Cars................	1,278,078
Employees...	779,608
Decrease since June 30, 1893 (11 per cent.)........................	93.994
Capital stock (common)....	$5,103,584,166
“ “ (preferred)...........	730,495.493
“ “ (total)	4,834,075,659
Funded debt...	5.356,583,019
Current liabilities...................	605,815,135
Dividends, for the year........	95,575,976
“ average rate, on dividend paying stock	5.41
Gross earnings, year...	$1.073,361,797
Decrease from previous year ...	147,390.077
Operating expenses	731,414,322
Decrease	96,506,977
Decrease in expenditure for M. W. p. c.	15.12
Decrease in expenditure for maintenance of equipment, p. c....	17.32
Net earnings...	$341,917,475
Other income........................	142.816,805
Fixed charges, etc	429,008,310
Net, available for dividends.......	55,755.970
Employees killed	1,823
“ injured...................	23,422
Passengers killed.	324
“ injured	3,034

This report covers the last four months of the Columbian Exposition; the remainder of the year the business depression had full effect. June 30, 1894, 192 roads were in the hands of receivers operating 42,000 miles and representing about one-fourth of the total capitalization. Fifteen roads (1,734 miles) have been merged, 22 roads (2,352 miles) reorganized and 14 roads (1,590 miles) consolidated. Over 56 per cent. of the total mileage is operated by 44 roads; 90 roads operate 82.9 per cent.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

RAILROADING.

*31616. First Principles in Railroad Management. Benjamin Reece (Eng Mag–July.) 2800 w.

*31617. The Legislative Regulation of Railroads. Albert Fink (Eng Mag–July.) 5300 w.

*31618. Reforms in Railroad Management. Henry Clews (Eng Mag–July.) 3200 w.

*31619. Will Trunk Lines Be Operated by Electricity? Frank J. Sprague (Eng Mag–July.) 3000 w.

*31621. The Advance in Railroad Securities. Thomas L. Greene (Eng Mag–July.) 3000 w.

*31622. The Car Building Industry of the United States. John C. Wait (Eng Mag–July.) 4000 w.

We supply copies of these articles. See introductory.

*31623. A Glimpse of "The Silvery San Juan." Ill. T. A. Rickard (Eng Mag–July.) 3500 w.

*31624. The Modern Railroad Machine Shop. H. D. Gordon (Eng Mag–July.) 3000 w.

*31625. A Review of Railroad Invention. C. P. Mackie (Eng Mag–July.) 3500 w.

†31672. The Economy of Colonial Railway Management (*Ind & East Eng*–April 13.) 3300 w.

31677. The Railroad Problem from a Shipper's Point of View. Charles W. Wells (Ry Rev–May 11.) 1100 w.

31678. An Improved Fastening for Steel Ties and Tie Plates.—Patent of E. H. Stone. Ill. (Ry Rev–May 11.) 1200 w.

31679. The Electric Railway for Interurban Traffic. Ralph W. Pope in Electric Power (Ry Rev–May 11.) 1800 w.

31687. Railway Building in Japan. Ill. (Ry Age–May 10.) 1200 w.

31726. Weight per Square Inch on Journals. E. W. Grieves (R R Car Jour–May.) 1200 w.

31727. Rule 8—Ad Libitum. George S. Hodgins (R R Car Jour–May.) 1800 w.

31728. Freight Car Doors and Fixtures.—Report of J. D. McIlwain. Ill. (R R Car Jour–May.) 1700 w.

31730. Painting, Paints and Varnishes as Applied to Railroad Equipment. (Abstract) G. W. Lord (R R Car Jour–May.) 1200 w.

*31735. Electric Locomotives for Railway Service. Ill. (*Ry Wld*–May.) 1100 w.

*31736. Some Links in Locomotive History. Ill. Clement E. Stretton (*Ry Wld*–May.) 1200 w.

*31737. A Locomotive with a History. Ill. Anon. (*Ry Wld*–May.) 700 w.

*31755. The Light Railways Bill (*Trans*–May 3.) 3000 w.

31781—$1. The Industrial Services of the Railways. Emory R. Johnson (An Amer Acad–May.) 6000 w.

31797. The Financial Value of Street Railway Franchises. E. Ray Stevens, in the "Outlook" (Elec Rev–May 15.) 1200 w.

31825. The Efficiency of Compound Locomotives. F. W. Dean (R R Gaz–May 17.) 7400 w.

31826. A Gasoline Motor Inspection Car. Ill. (R R Gaz–May 17.) 300 w.

31827. The Effect of Negative Lead in Locomotives. Editorial (R R Gaz–May 17.) 1700 w.

31853. Effect of Pooling Agreements upon Commerce. George R. Blanchard (R'y Age–May 17.) 3500 w.

*31863. The Coming Railways of India and Their Prospects. J. W. Parry, with Discussion (*Jour Soc of Arts*–May 10.) 16500 w.

*31879. The Intercontinental Railway. W. D. Kelley (Stone–May.) 1800 w.

*31896. The Great Western Railway. Anon. (*Trans*–May 10.) 3500 w.

*31915. Railway Location and Construction as Practiced in the Western States. W. B. Lawson (Jour Asso Eng Soc–April) 7800 w.

*31916. On the Best Arrangement of Longitudinal Bracing for Timber Trestles. Ill. M. E. Yeatman (Jour Asso Eng Soc–April.) 2200 w.

*31920. The Metropolitan West Side Elevated Railroad of Chicago.—The Finest Elevated Road in the World. Ill. (St R'y Rev–May.) 4000 w.

*31921. Tramway Ambulance Service. Ill. (St R'y Rev–May.) 1100 w.

*31922. Electric Incline Railway at Great Falls, Montana. Ill. (St R'y Rev–May.) 900 w.

*31923. Geneva Street Railways. Ill. (St R'y Rev–May.) 700 w.

31936. Homely Advice.—A Brief Discussion of How to Ride in a Railway Train. (Humorous.) Chester N. Farr, Jr. From the Am. Law Register & Review (R'y Rev–May 18.) 3000 w.

31938. Regulations of State and Interstate Electric Railways. G. M. Woodruff (R'y Rev–May 18.) 1700 w.

31940. Notes on Pipe Electrolysis. Maurice Hoopes (Elec Wld–May 25.) 1800 w.

31948. Suspended Railway Systems. Ill. (Sci Am–May 25.) 900 w.

*31957. Test of Ithaca Street Railway Power Plant. Ill. Thomas McNeil and W. S. Manning (Sib Jour Eng–May.) 800 w.

31984. The Practical Use of Transition Curves. Walter Loring Webb (R R Gaz–May 24.) 1800 w.

31987. Organization of the Prussian State Railroads. Editorial (R R Gaz–May 24.) 1500 w.

*32053. The Railway Death Bill (*Trans*–May 17.) 1100 w.

32071. Schenly Park and Highlands Railway of Pittsburg. Ill. (St R'y Gaz–May 25.) 1300 w.

32073. Uniformity in Classification of Freights—Progress Toward It (R'y Age–May 24.) 1300 w.

32082. Fuel Saving on a Western Railway (R'y Rev–May 25.) 1400 w.

32083. Cause of the Uneven Wear of Driving Wheel Tires. Report of Committee (R'y Rev–May 25.) 900 w.

32084. The Use and Misuse of Socialistic Writing. Editorial on Article in Arena, with Abstract (R'y Rev–May 25.) 1400 w.

32133. Brick Arch Culverts; St. Louis, Keokuk and North-Western Railroad Extension. Ill. (Eng News–May 30.) 800 w.

32135. The Construction of the Boston Subway. Ill. (Eng News–May 30.) 4300 w.

32144. Chicago's Street Railway Mail Car. Ill. (W Elec–June 1.) 700 w.

32150. What is the Limit of the Passenger Capacity of a Suburban Track. Fr. von Emperger (R R Gaz–May 31.) 1400 w.

32151. Heavy and Hard Rails on the Boston and Albany. Ill. (R R Gaz–May 31.) 1800 w.

32152. Cold Storage Plant at Port Richmond, Philadelphia. Ill. (R R G–May 31.) 1600 w.

32153. The Railroads, the City and the Suburbs. Editorial. (R R Gaz–May 31.) 2500 w.

†32173. The Decline in Railway Charges. H. T. Newcomb (Pop Sci M–June.) 3000 w.

*32182. Railways and Harbors in New South Wales (*Trans*–May 24.) 1500 w.

32244. Railroad Patent Litigation—The Under Running Trolley. Ill. (Elec–May 29.) 5300 w.

†32269. The Street Railway System of St. Louis. Ill. (St R'y Jour–June.) 26300 w.

†32270. The Economy of Street Railway Cables. Ill. R. J. McCarty (St R'y Jour–June.) 3800 w.

*32274. Proposed Air-Brake Rigging, with Uniform Levers for all Classes of Freight Cars. Ill. B. Haskell (Loc Engng–June.) 2300 w.

*32275. High-Speed Locomotives. William Barnet Le Van (Loc Engng–June.) 2500 w.

*32277. Some Principles of Design. George S. Hodgins (Loc Engng–June.) 2400 w.

*32284. The Design of Cars and Locomotives Considered Architecturally. R. S. Atkinson (Nat Car Build–June.) 1600 w.

32299. A Portable Single Rail Surface Railway. Ill. (Sci Am Sup–June 8) 1400 w.

32303. 70000 lb Hopper-Bottom Ore and Coal Car; Pennsylvania Lines. Ill. (Eng News–June 6.) 1200 w.

32306. Equipping Freight Cars with Air-brakes and Automatic Couplers. Editorial (Eng News–June 6.) 2000 w.

32310. Additional Notes on the Efficiency of Compound Locomotives. F. W. Dean (R R Gaz–June 7.) 1000 w.

32311. The New York Railroad Construction Law (R R Gaz–June 7.) 1200 w.

32312. The Master Car Builders' Rules of Interchange. J. N. Barr (R R Gaz–June 7.) 4000 w.

32313. The Present Work of the Master Car Builders' Association. Editorial (R R Gaz–June 7.) 3200 w.

32316. The Pros and Cons of the Interchange Question. Editorial (R R Car Jour–June.) 2700 w.

32317. The Car Coupler Law About to Take Effect. Edward A. Moseley (R R Car Jour–June.) 900 w.

32318. The Life of Freight Equipment and Cost of Maintenance. A. M. Waitt (R R Car Jour–June.) 1800 w.

32319. The M. C. B. Scylla and Charybdis. George S. Hodgins (R R Car Jour–June.) 2500 w.

32320. What Shall Be Done with Our Interchange? E. W. Grieves (R R Car Jour–June.) 900 w.

32321. Progress in Metal Car Construction. J. D. McIlwain (R R Car Jour–June.) 1100 w.

32322. Foundation Brakes. Anon. (R R Car Jour–June.) 4800 w.

32323. Progressive Car Shop Practice. James F. Hobart (R R Car Jour–June.) 1600 w.

32325. M. C. B. Rule No. 8—Possible Results of Extension of the Principle of Car Owners' Responsibility. J. D. McAlpine (R R Car Jour–June.) 1800 w.

32331. The Growth of Transportation Facilities in Southwest Louisiana. W. W. Duson (Mfr Rec–June 7.) 1300 w.

*32341. The Westinghouse Quick-Acting Brake. Editorial (*Engng*–May 31.) 1800 w.

*32397. The Causes of Railroad Accidents. Julien A. Hall (Eng Mag–July.) 3000 w.

Serials.

24586. Railway Companies and Their Employés. O. D. Ashley (R'y Age–Began Aug. 24, 1894—11 parts to date—15 cts. each).

27603. A Treatise on the Construction of Railroad Rolling Stock. A. Flamanche, A. Huberti and A. Stevart (R R Car Jour–Began Dec. 1894—6 parts to date—15 cts. each).

28138. Block Signaling. Ill. W. H. Elliott (Loc Engng–Began Jan.—6 parts to date—30 cts. each).

28496. Electric Traction. Ill. Philip Dawson (*Engng*–Began Jan. 4—19 parts to date—30 cts. each).

28897. Motor Repairs. W. E. Shepard (St R'y Jour–Began Feb.—5 parts to date—45 cts. each).

29369. Tramway Management. By a Manager (*R'y Wld*–Began Feb.—4 parts to date—30 cts. each).

30604. Locomotive Repair Shop Equipment. W. H. Weston (Nat Car Build–Began April—3 parts to date—30 cts. each).

30654. Electric Railway Repair Shops. Henry P. Merriam (St R'y Jour–Began April—3 parts to date—45 cts. each).

31147. Mountain-Climbing Railways. Ernest Scott (*Elec Eng*–Began April 12—Ended May 31—3 parts—30 cts. each).

31211. The Stresses in Car Axles (R R Gaz–Began April 26—Ended May 24—4 parts—15 cts. each).

31293. State Railways in Western Sumatra. Ill. (*Engng*–Began April 19—Ended May 10—2 parts—30 cts. each).

31365. Boiler-Making. Ill. C. E. Fourness (Loc Engng–Began May—2 parts to date—30 cts. each).

31646. The Union Terminal Station at St. Louis. Ill. (*Engng*–Began May 3—Ended May 31—3 parts—30 cts. each).

31673. The Life of Railway Axles. Thomas Andrews (*Ind & East Eng*–Began April 13—2 parts to date—45 cts. each).

31738. Compressed Air Motors for Tramway Traction. Ill. H. Conradi (*R'y Wld*–Began May—1 part to date—30 cts).

SCIENTIFIC MISCELLANY

The Great Libraries of the United States.

Of these Mr. Herbert Putnam, librarian of the Boston Public Library, discourses pleasantly in *The Forum* for June, and points out certain tendencies, which have attracted little attention on the part of the general public. The present appears to be an era of library founding in the United States.

"During the past 13 years seven events have occurred which, either by the novelty of the ideas they represented or the magnitude of the interests they involved, have directed public attention peculiarly to one department of education. In 1882 the Enoch Pratt Library was founded in Baltimore; in 1887 the Newberry Library was founded in Chicago; in 1894 the Crerar Library was established in Chicago; and in the present year the new buildings of the Boston Public Library, of the Chicago Public Library, and of the Congressional Library will have been completed, and the consolidation of the Astor, Lenox, and Tilden Foundations will have been effected. Within the past few weeks, also, the superb gift of President Low makes it certain that the great new building for the Columbia College Library will be undertaken. These seven events have gained a popular prominence; but to them should be added certain others, which, although not perhaps as impressive in their immediate results, may prove even more far-reaching,—the work of certain State commissions, as in Massachusetts and New York, in extending State aid to the establishment of local libraries."

Mr. Putnam asserts that, "if not from the days of Alexandria, at least from the invention of printing down to the middle of the nineteenth century only one new type of library was added to those already existing,—the subscription library, whose creation was due to the simple sagacity of Benjamin Franklin. With the passage almost contemporaneously in England and in two of the United States of the enabling acts which authorized the formation of public libraries supported by general taxation, another new type was created. The act of Massachusetts was in 1848 (a special act—a general act followed in 1850); that of New Hampshire in 1849; that of Great Britain in 1850. The two libraries first to be established under these acts—the library of Manchester, England, and the library of Boston, both established in 1852—were the pioneers of this new type. Their example proved amazingly attractive, so that to-day the Manchester library is but of one of two hundred of its kind in Great Britain, and the Boston but one of more than nine hundred of its kind in the United States. The characteristics of those two libraries must, therefore, to some extent represent the characteristics of two entire groups."

The libraries of Boston and Manchester are both municipal institutions supported by general taxation. The municipal funds for purchase of books are expended primarily for books of general interest, and books for specialists are made secondary to the desire that popular reading shall be encouraged and promoted. To afford facilities for the general taste for reading which our public schools cultivate, and enable those who have such advantages to continue the cultivation thus begun at the public expense, was the principal purpose of their institution. "From the first . . . . the Boston library was adopted into a relation with the system of common-school education."

Mr. Putnam emphatically denies that such libraries are eleemosynary institutions. "The public library in the United States . . . was created by and for a people wonted to the notion of a free-school system. In making use of it, they feel as little the objects of charity as they do in sending their children to the public schools. In both cases they are the patrons, not the beneficiaries. More than this, they have a sense of ownership in, and control over, these institutions."

The intent was to "*supplement* the work of the common school"; but a movement "not then foreseen . . . is now enabling the public library to complement" that work. "As a result of this movement (developed under the leadership of the Worcester, Mass., Public Library) the schools draw directly upon the library for books to be used in class work; so that the library is woven in with the whole system of common-school education."

"It was the establishment, in 1876, of the American Library Association and of the '*Library Journal*,' and of a series of annual conferences of librarians, that both induced concerted effort and rendered it possible. And systematic training is now represented in the United States, in the first place by seven library schools (that of the New York State Library, that of Pratt Institute, Brooklyn, that of the Drexel Institute, Philadelphia, that of the Armour Institute, Chicago, and those of the Denver and of the Los Angeles Public Libraries, and that conducted during the summer at Amherst, Mass.), and in the second place by courses in bibliography and library economy, now forming part of the regular curriculum in various colleges (Amherst, Bowdoin, California, Colorado, Cornell, Iowa, Maine, Michigan, Wellesley)."

The tendency to increase the facilities for prompt access to books in libraries is one of the features of modern library development. "Whether or no it be true abroad, it is certainly true in the United States that such measures as have been taken to strip library administration of its formalities, and to render access to the books easier and more direct, have been taken under the initiative of the librarians themselves. If there has been any reluctance to do away with formalities, it has been on the part of persons who, not being brought into close and daily contact with the reading public, as is the librarian, cannot realize as he does that it is the specialist, who by education has the greatest respect for literature, who is apt to show the least respect for books; and that the library, if it suffer depredations, suffers least of all from the ordinary reader, who, without knowledge to induce so great a respect for literature, is guarded by a greater reverence for books. A small library, with a small body of readers, may without difficulty permit direct access to its books. As the library grows and readers become more numerous, the books are apt to be drawn farther and farther away, and catalogues substituted in their place. After years of effort in the endeavor to devise perfect systems of cataloguing, our libraries are now trying, as far as possible, to substitute for the catalogue personal mediation and direct contact with the books. It is felt that, unless this can be effected, large libraries will lose some of the agencies for good which small libraries possess."

A Cable Post.

An article by J. Henniker Heaton, M.P., in *The North American Review* for June, discusses the possibilities of Atlantic submarine communication under the title, "A Cable Post." Those who care to learn how an English parliamentarian regards the facilities now afforded by cables between the two continents will find it a very readable paper.

"Why has this grand experiment, on which we grown men looked, as boys, with breathless interest, proved a miserable failure? The obvious explanation is that a shilling a word is a prohibitive rate, which can only be borne in the small class of transactions yielding extraordinary profits, or under the pressure of sheer necessity. If a man with a business of moderate dimensions corresponds with London customers by letter, knowing that his wealthy rivals habitually employ the cable for the same purpose, it is not because he prefers a week's delay, but because he cannot help himself. On the other hand, capitalists would be glad to have the rate five dollars a word, in order to kill the competition of poorer men. Yet even rich men writhe a little in the grip of the cable companies; and this is why 97 per cent. of the messages are sent in code. The proportion of social messages exchanged between relatives and friends on matters of private concern—only 3 per cent.—is so small as to be hardly worth taking into account at all."

The control of the Atlantic cables is in the hands of "a monopoly." "Strictly speaking, it is a duopoly, for there are two groups of share-holders interested; but these two maintain a common tariff," and "all the evils of a monopoly exist. . . . The true culprits are the British and American governments, which have allowed private persons to undertake State responsibilities and to intercept benefits that belong to the public at large."

"Nominally six companies carry on the trans-Atlantic cable traffic,—namely, the Anglo-American Telegraph Company, the Western Union Telegraph Company, the Commercial Cable Company, the Direct United States Cable Company, the American Cable Company, and the Paris and New York Cable Company. Of these, however, the American Telegraph and Cable Company is (according to *Burdett's Intelligence*) leased to the Western Union Telegraph Company, and the Anglo-American Telegraph Company receives 48.825 per cent. of the receipts of four companies,—namely, the Direct United States Cable Company, the Paris and New York Cable Company, and the American Telegraph and Cable Company (now leased, as stated, to the Western Union Telegraph Company). It is clear, therefore, that competition is practically confined to the Anglo-American Telegraph Company and the Commercial Cable Company, the former of which controls nine cables (five of its own and four of its allies), while the latter has three at its disposal."

The total capital invested in these companies is about $60,000,000, on which handsome dividends are paid. "The number of words sent over the cables between America and England last year was 23,000,000. Of these 20,000,000 were business messages at 1s. per word, and the balance, 3,000,000, were messages at 5d. per word. Deducting some small charges, the total income from Anglo-American cables may be put down at $5,000,000.

"Now, by means of the recent improvements, forty-five words per minute can be sent over one wire, so that the twelve cables might be employed to send in 1 year no less than 283,824,000 words! It must be remembered, however, that only two of the twelve cables are extensively employed. Indeed, a cable expert of high authority is of opinion that the new cable of the Anglo-American Company, having a weight of 400 lbs. of copper to the mile, is of sufficient capacity to carry all the existing traffic."

The extensive use of codes has some curious features. "One man is known to have paid £3000 for a good code. These codes are sometimes over-significant. Thus the word 'man' might mean 'Readings declined one-tenth.' 'Penns. rose one-fifth,' and 'New York Central steady.' And again the word 'wormlike' means in one code: 'The price is 10s.; appearing high as compared with your market. We took refusal until to-morrow, and shall buy unless you immediately instruct us to the contrary.' This message of twenty-eight words was sent as one word, to the disgust of the shareholders and managers of the cable companies. No code can properly anticipate a social or family message. Such codes as have been prepared are rarely used, for it is difficult to prepare a cut-and-dried programme of the diversified events of daily life. An attempt was made some years ago to charge double and treble for code words. But the merchants were too clever, and an apparent social message, such as that 'John married Eliza,' often conveyed the most recent market rates for corn."

Mr. Heaton asserts that the public pays £1,000,000 a year for what could be supplied at £130,000, and that, if the cables were destroyed, the present facilities could be constructed for £6,000,000; and he proposes "that the British and American governments should jointly acquire the properties and rights of the existing companies at a fair valuation, and establish a common State monopoly in cable communication." This suggestion is likely to be earnestly considered and advocated in the near future.

The Scientific Uses of Liquid Air.

THE discovery of Prof. Dewar by which air may be quickly and readily liquefied in quantities sufficient for use in scientific investigations seems calculated to add largely to the store of scientific facts. *The Electrical Review* (May 3) says: "To make a scientific discovery is one thing; to apply it to the arts or industries is distinctly another. It is often much more difficult to realize the scientific and economical bearing of a fact than it is to find it out. Prof. Dewar seems to combine within himself that faculty rarely found in scientific men, —namely, of knowing what to do with his discoveries when he has made them. This we contend is the highest attainment. A man who simply amasses data and knows not how to deal with them is in the position of one who, possessing the wit to accumulate money, is incapable of using or enjoying it."

A statement of the applications of liquid air already made shows that the belief above is by no means chimerical. "Speaking generally, the chief scientific uses of liquid air consist in the facilities it gives for the study of the properties of matter at temperatures approaching the zero of absolute temperature. For a number of purposes it does not matter whether liquid air or oxygen is employed. Prof. Dewar, who has been working in conjunction with Prof. Fleming, appears to have used these substances almost indiscriminately, and the experiments made have largely partaken of a qualitative character. This, however, was in the nature of things, for investigations on the properties of matter at the temperature of boiling liquid air must necessarily, in the first instance at least, be largely qualitative rather than rigidly quantitative.

"In the science of optics, in the study of specific heats and of the cohesive forces, of modifications in chemical affinity and of magnetic conditions at low temperatures, liquid air has already been the means of attaining facts; and facts are always valuable, though a true estimate of their value often comes long after their first discovery. So far, the experiments which have been carried out seem to point to, if not warrant, the conclusion that at the zero of absolute temperature all the pure metals would be perfect conductors of electricity. Under such conditions a current of electricity started in a pure metallic circuit would develop no heat, and therefore undergo no dissipation. Similarly it may be inferred that there would be no Peltier effect at the zero; in other words, the passage of electricity from one metal to another would take place without evolution or absorption of heat. Liquid air is stored in glass vacuum vessels, which are either cylindrical or spherical in shape. Hence these vessels can act as lenses. This fact facilitates the examination of the refractive indices of liquid nitrogen and air. . . . For some time Prof. Dewar has projected a series of observations on the thermal capacity of liquid oxygen and nitrogen, but the difficulties inherent to the task have barred the way. He has now succeeded in using these glass vacuum vessels containing liquid gas for the purpose of determining approximately the relative thermal transparency for heat of high refragibility. Liquid oxygen appears to be one of the most transparent liquids known in relation to heat. The results obtained, although probably only approximating to the truth, may be regarded as confirmatory of the inferences Tyndall drew as to the relation between gases and liquids as absorbents of radiant heat.

"By a beautifully simple device Prof. Dewar succeeds in storing liquid air so that it shows no signs of ebullition, the surface remaining as quiet and still as if it were ordinary water. This is accomplished by silvering the interior and exterior of the vacuum vessels, a little excess of mercury being left, so that, in the act of filling the inner vessel with the liquid air, the metal is deposited as a fine silvery film."

The Volterra Alabaster.

WHILE in various localities in Southern Europe stones exist that are of nearly the same chemical composition as the alabaster of Volterra, and some which are called alabaster by courtesy, although their composition is different, the *Journal of the*

Society of Arts (May 24) says they are of such poor quality as compared with that obtained in the district of Volterra as to leave the latter without a rival. The alabaster spoken of in the Bible was a species of marble. The alabaster of Volterra is a hydrated sulphate of lime, and is asserted to be found in a condition fit for the production of the highest class of alabaster work nowhere in the world except in the province of Pisa. Of course this refers to what is now called alabaster, not the scriptural alabaster—a species of marble—of which boxes for fragrant ointments and for other purposes were made. The ancient Etruscans made cinerary urns of the same material that is now called alabaster. Many of these may be seen in a local museum in Volterra, which was one of the twelve cities of the Etruscan League. This review will take the form of a running abstract of the article named, exhibiting features of an industry little known outside the district in which it is carried on.

The alabaster districts may be divided into two parts. In the first may be included all the caves (the word "caves" more accurately describing the nature of the workings, which are subterranean, than the word quarries) lying round about Volterra. The second division is composed of the communes of Castellina and Santa Luce, where, in the valley of the Marmolaio, are situated on the left bank the historic caves of Castellina, and on the right bank the less known, but equally important, caves of Pomaia. The reason of this division is that the alabaster of the caves of the Marmolaio valley, which, following the custom of the dealers and workers of Volterra, is called Castellina alabaster, has a whiteness, a purity, and a transparency not to be found in the alabasters of the other communes, and because it, and it alone, is used in that flourishing branch of the industry which is devoted to the sculpture of figures. There are many different varieties of alabaster found in the whole district. Dr. Targion Tozzetti, writing 100 years ago, has elaborately described fifty-two, but it will be sufficient for all practical purposes to divide the whole class into five clearly-defined species, as follows: the white alabaster of Castellina, a luminous and transparent stone of faintly cerulean tint; the white alabaster of Volterra, a mineral of an opaque, milky, and even cream-white color; veined, striped, or spotted alabaster, in its many fanciful and beautiful varieties; *bardiglio*, a greyish stone of the nature of alabaster, which, when cut and polished, has somewhat the appearance of the grey marble known as "dove" in the English trade; and, finally, the agatized alabaster, called at Volterra *agata*, an extremely beautiful and yellow stone, varying in color, when polished, from dark amber to deep, rich brown. The *bardiglio* is the cheapest, and the *agata* is the rarest and most expensive, species of alabaster.

The Castellina alabaster is especially prized on account of the large size of the blocks found. Nearly three-fifths of the alabaster for sculpture which is excavated at Pomaia is in blocks weighing at least six cwt., while blocks of from seventeen to twenty cwt. are of common occurrence. A block weighing 58 cwt., and having a length of 5¼ ft., was sent to the late Antwerp Exhibition. Working in the caves appears to be healthy; the workers all live to a good old age. They have a belief that the fine white alabaster powder has strong hygienic properties. The worked alabaster industry is divided into two strongly differentiated branches: first, sculpture,—that is, sculptured representations, whether on a large, or small scale, of the human form; and, second, the miscellaneous industry. This latter comprises objects manufactured at Volterra, such as vases, ewers, pillars, stands, baskets, clock-cases, frames, toilet necessaries, animals, fruits, ash-trays, candelabra, crucifixes, holy-water stoups, etc. Nearly all the best sculpture of alabaster is now carried on in Florence; the miscellaneous industry is almost confined to the city of Volterra.

In former days there were three distinct classes of workers,—the master artist or worker who owned a large workshop, employed numerous workers, and sold his products direct to the alabaster shops, or galleries, as they are called, of Leghorn, Pisa, Florence, and Volterra; the journeymen workers; and the travelers,—men who travelled not merely with samples, but with huge cases of the goods, selling them as they went along. The master worker and the traveller are now extinct species. The modern system of labor and distribution is entirely different. Walking along the by-streets of Volterra, the ear is arrested by the clinking of little hammers or the grating rasp of files; and, looking at a doorway, the passer-by will see two or three men busily engaged with all the application of true artists in fashioning the various parts of a vase or a flower-basket. These men may be a father and his sons, or three men united in an informal partnership, and they usually unite in themselves the manual skill required for the production of a vase, one being a turner who gives it shape, another a modeller who fashions its pillar and base, and the third a decorator who carves its adjuncts of fruit and flowers. The master worker, with his busy band of workers and apprentices, has disappeared, and the articles named come from these small shops.

Preserving Wood and the Haskinizing Process.

YEARS ago a process of seasoning timber and rendering wood more resistant to the action of atmospheric influences, as well as less liable to the attacks of insects, by treating it with steam and bringing it to a temperature at which coagulation of the coagulable substances contained in it is effected, attracted some attention. It was found that wood could thus be seasoned, and its resistance to decay increased. Some thought, however, that the strength of wood thus treated was inferior to that slowly seasoned in the old way. The wood, taken out while hot, had thus parted with much of the water holding in solution the non-volatile substances in the sap, and the residual heat quickly dried it, enabling the process of seasoning to be completed in little more than the time necessary for putting the wood in the apparatus, heating it throughout its texture to the desired temperature, taking it out, and finally cooling it down to normal temperature in the open air and in a dry place.

No one thought that retaining the water contained in the sap during the heating could be of any benefit, since its evaporation cannot be rapidly effected by heat without at the same time producing the desired coagulation. However, the retention of the water of the sap in the wood during the heating process is now claimed to be the explanation of alleged improvement of quality in "vulcanized wood" obtained by a process called Haskinizing, described in *The Marine Engineer* (May 1). The inventor of this process, Colonel Haskin, has been exhibiting wood treated by it in London. While it is claimed that the wood is thus protected from decay, special claims that it is handsome in appearance, easily worked with tools, and free from any offensive odor are also made. The process, it is stated, is conducted in a cylinder made of boiler-plate sufficiently strong to withstand an internal pressure of super-heated circulating air compressed to several atmospheres, for the purpose of holding the fluids of the wood from evaporation. The wood is piled on cars, which are run into the cylinder, and the air is pumped from a large compressor into the cylinder, after it has passed through a small stove or furnace, so as to become super-heated.

The air pressure holds the sap or fluids in the wood, effectually preventing their evaporation, while the intense heat passing through and clear to the centre of the timber, so sublimates and attenuates the fluid matter of the wood that a new compound is formed, or, rather, the constituent elements of the sap are thus caused to enter in combination with one another, which, under lower degrees of heat, are distilled or desiccated separately.

It is claimed that the ingredients hitherto distilled out of wood by various processes of treatment are valuable antiseptics, and should be retained in the timber. There does not seem a chemical warrant for this claim, and, even if there were, it is not obvious how their evaporation is prevented by the use of hot air, more than by steam at an equal temperature.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*31660. The Scientific Uses of Liquid Air. Ill. (*Elec Rev*-May 3.) 2000 w.

†31731. Color Shadows. A. E. Wright *Nineteenth Cent*-May.) 5600 w.

*31762. A New Wood Preserving Process *Marine Eng*-May.) 700 w.

*31772. Air-Tight Steel Storage. L. LaRue Smith (Milling-April.) 1500 w.

†31775. Some Physical Aspects of the New Gas, Argon.—The Ideal Thermo Metrical Substance for High Temperatures W. R. Quinan Jour Am Chem Soc-June.) 2000 w.

†31777. Danish Butter-Making. Ethel B. Tweedie (*Fort Rev*-May.) 6500 w.

31778.—$1. Uniform State Legislation. Frederic Jesup Stimson (An Amer Acad-May.) 2500 w.

31810. Lake Basins Created by Wind Eroion. G. K. Gilbert (Sci Am Sup-May 18.) 00 w.

31812. Summary of Conclusions of a Report y Drs. D. H. Bergey, S. Weir Mitchell and J. S. Billings upon "The Composition of Expired Air and Its Effects upon Animal Life." (Sci Am Sup-May 18.) 2000 w.

31814. Some Reminiscences of Frederick E. Sickles. John T. Hawkins (Am Mach-May 16.) 000 w.

*31835. The Story of Human Progress (Self Culture-May 15.) 800 w.

31891. A Hole Nearly a Mile Deep —One of he Novelties of the Next Paris Exposition (Bos our Com-May 18.) 1500 w.

*31917. The Relation of Technical to Liberal Education. C. M. Woodward (Jour Asso Eng Soc-April.) 6400 w.

*31918. The Manufacture of Cement from Furnace Slag. Hermann Crueger (Jour Asso Eng Soc-April.) 3000 w.

*31950. The Scientific Progress of the Nineeenth Century. Dr. Paul Carus (Chau-June.) 000 w.

*31961. Chicago before the Fire, after the Fire and To-day. Ill. Melville E. Stone (Scrib M g-June.) 4000 w.

*31962. The Bicycle. Ill. I. The Wheel f To-day. Philip G. Hubert, Jr. II. Woman nd the Bicycle. Marguerite Merington. III. Doctor's View of Bicycling. J. West Rooseelt (Scrib Mag-June.) 12500 w.

†32010. Engineering Facts vs. Credulity. eorge Y. Wisner, in "The Technic" (*Ind & ast Eng*-April 27.) 2000 w.

*32050. Means for Mitigating the Fading of igments. W. de W. Abney (*Jour Soc of rts*-May 17.) 4500 w.

*32056. Terrestrial Helium (*Nature*-May) 2200 w.

*32078. The Natural Basis of Decorative rt. Charles L. Condit, in Painting Decorat-g (Arch, Build & Dec-March.) 3000 w.

†32091. Argon. Résumé by E. Waller (School of Mines Quar-April.) 1700 w.

32108. The Moon's Story. Robert Ball (Sci Amer-June 1.) 2800 w.

32110. The Stained Glass Window Industry. Ill. (Sci Amer-June 1.) 900 w.

†32113. Daily March of the Wind Velocities in the United States. Frank Waldo (Am Jour Sci-June) 4000 w.

†32114. A Newly Discovered Dike at De Witt, near Syracuse, New York. Geologic Notes by N. H. Darton. Petrographic Description by J. F. Kemp (Am Jour Sci-June.) 2500 w.

†32115. Note on the Amount of Elevation Which Has Taken Place Along the Rocky Mountain Range in British America Since the Close of the Cretacious Period. G. M. Dawson (Am Jour Sci-June.) 900 w.

†32215. Remarks on Daimonelix, or "Devil's Corkscrew," and Allied Fossils. Ill. Joseph T. James (Am Geol-June.) 1500 w.

†32216. A Contribution to the Geology of the Coast Ranges. Andrew C. Lawson (Am Geol-June.) 4500 w.

†32217. Canadian Localities of the Taconic Eruptives. N. H. Winchell (Am Geol-June.) 2500 w.

†32218. Recent Contributions to our Knowledge of the Cladodont Sharks. E. W. Claypole (Am Geol-June.) 1600 w.

†32219. Auriferous Gravels of the Sierra Nevada. H. W. Turner (Am Geol-June.) 2500 w.

*32259. Engineers of To-day and Yesterday. Thomas Bell Lightfoot. Ill. (*Eng Rev*-May 20.) 900 w.

*32268. The Great Libraries of the United States. Herbert Putnam (*Forum*-June.) 5000 w.

†32281. The Work of the Sanitary Engineer in Time of Epidemics, in Time of War, and in Sudden Calamities in Civic Life. William Paul Gerhard (San-June.) 5500 w.

Serials.

24462. Graphic Statics. Ill. W. W. F. Pullen (*Prac Eng*-Began Aug. 10, 1894—19 parts to date—30 cts. each).

27198. Refrigerating and Ice-Making (Sta Eng-Began Nov., 1894—6 parts to date—15 cts. each).

29531. A History of the Last Quarter-Century in the United States. Ill. E. Benjamin Andrews (Scrib Mag-Began March—4 parts to date—30 cts. each).

31852. The Liquefaction of Gases.—Review of series of lectures by Prof. Dewar (*Eng*-Began May 10—2 parts to date—30 cts. each).

32220. Composition of the American Sulphur Petroleums. Charles F. Mabery (Jour Fr Inst-Began June—1 part to date—45 cts).

NEW TRADE CATALOGUES.

McIntosh & Seymour, Albany, N. Y., U. S. A.—Catalogue, 40 pp., 10¼″×8½″. [Describing and illustrating a fine line of automatic cut-off engines of different types. Elegantly printed; cover, robin's-egg blue, embossed.]

H. E. Collins & Co., Pittsburg, Pa., and Chicago, Ill., U. S. A.=Pamphlet, 45 pp., 5¾″×7½″. [Describing and illustrating the "Cahall" Vertical Water Tube Boiler. The pamphlet discusses the requirements of a perfect steam boiler. Beautifully printed and profusely illustrated throughout. Cover, blue and gold.]

Henry R. Worthington, New York, U. S. A. =Pamphlet, 36 pp., 5″×6½″. [Illustrating and describing the Worthington water meter, with an introduction discussing the requirements of good water meters. Also containing hydraulic tables and much useful information relating to the subject of water-supply in cities. Nicely printed and illustrated; cover, red and black.]

Henry R. Worthington, New York, U. S. A. =Pamphlet, 24 pp., 5″×6½″. [Describing the Worthington steam pumps for brewery and distillery service. The description is confined to pumps for these special uses. Nicely printed and illustrated; cover, red and black.]

The Kinnear & Gager Co., Columbus, O., U. S. A.=Catalogue, 32 pp., 11½″×8½″, with leaflet containing price-list. [Illustrates and describes interior decorations consisting of interior metal work, ceiling and rolling metal partitions, doors, shutters, etc. This is one of the handsomest catalogues received this month. Cover, French gray and gold.]

Pencoyd Iron Works, Bridge and Construction Department, Pencoyd, Pa., U. S. A., 20 pp., 6¼″×10″=General Specifications for Railroad Bridges. Cover, robin's-egg blue and black.

F. E. Brandis' Sons & Co., Brooklyn, N. Y., U. S. A.=Illustrative and Descriptive Catalogue and Hand-book, 236 pp, 5¾″×8½″. [Illustrates and describes instruments of precision for civil engineers, surveyors, and astronomers, made by this firm. Besides descriptions of the instruments, the book contains a very large amount of useful information relating to the general use of such instruments, with mathematical explanations of the principles upon which they are based; it is, therefore, a valuable book to be placed in any engineer's library. Flexible cover, yellow and black. Price, 50 cts.]

Wrought Iron Bridge Co., Canton, O., U. S. A.=Pamphlet, 73 pp., 5¾″×4½″. [Describing and illustrating a great variety of work which has been executed by this company. The illustrations are half tone, beautifully printed, and include exterior and interior views of the works of the company, as well as structures erected by them. Cover, salmon yellow and black.]

The Huyett & Smith Mfg. Co., Detroit, Mich., U. S. A.=Catalogue, 138 pp., 6¾″×10″. [Describing and illustrating a long line of dry kilns, brick dryers, hot blast heating apparatus, ventilating fans, blowers, engines, marine water-tube boilers, cotton fans, exhaust fans, steam traps, blast gates. Beautifully printed on coated paper; cover, salmon yellow and red.]

Charles D. Mosher, No. 1 Broadway, New York, U. S. A.=Pamphlet, 35 pp, 4″×6¼″. [Discusses the subject of steam separators in a general and practical manner, and describes and illustrates the Mosher Steam Separator. Cover, French gray, red, and indigo blue.]

Samuel J. Shimer & Sons, Milton, Pa., U. S. A.=Catalogue, 140 pp., 7½″×10½″. [Describes and illustrates a great variety of the "Shimer" cutter heads for general wood working and the manufacture of flooring, ceiling, siding, wainscoting, ship-lap, O'G siding, plain jointing, glue jointing, sucker rods, hoops, trunk slats, blind slats, blind rods, flush door moulding, O'G doors, sashes, blinds, cope heads to match dado heads, and special tools for all accurate work with full-sized representations of wood patterns as made by these various tools described in the catalogue. This is a very complete and elegant book, nicely printed on coated paper; cover, robin's egg blue and black.]

The Taunton Locomotive Mfg. Co., Taunton Mass., U. S. A.=Catalogue 63 pp, 8″×10″. [Describes with 25 illustrations the various forms of the Wainwright appliances, viz., feed, water heaters, surface condensors, and expansion joints. (2) Leaflets, describing the Wainwright expansion joints with size and prices, and price list of the Wainwright water tube heaters and Wainwright steam tube heaters.]

M. C. Bullock Mfg. Co., Chicago, Ill., U. S A =Catalogue No 27, 3d Edition, 37 pp. 7¾″×10½″. [Describes and illustrates, with beautiful half-tone engravings, the Central Valve engine manufactured by this company. One o the plates is an illustration of the Gunning & Campbell engine at Belfast, and another a rep resentation of the large mill engine operating the cotton mill for Mr. Thomasson and Son of Boul ton, Eng. A noticeable feature of the catalogue is a letter and curves representing result of a tes of a Siemans-Willans set for Glasgow corpora tion, Siemans' dynamos II, B. 27-40, shunt wound No. 3053. Willans engine III, Central-valv compound No. 1533. These curves give th indicated horse power and electric horse-power the number of amperes at 225 volts and the per centage efficiency.]

The New York Central Iron Works Co., Gen eva, N. Y., U. S. A.=Pamphlet, entitled "Steam and Hot Water Heating by the Dunning Boiler." 16 pp., 3¼″×6″, with folding plates

The C. W. Hunt Co., New York, U. S. A.= Pamphlet 30 pp., 6½″×9¼″, entitled "Manil Rope for Transporting and Hoisting." [A brie treatise for engineers' on ropes used for th transmission of power, and for hoisting falls— together with formulæ, tables and other partic ulars useful in mill engineering. The pamphle is beautifully printed with half-tone illustration and line engravings. Cover, French grey an black. (2) Envelope containing useful table printed on paper with gummed backs for cor venient insertion in memorandum books. Th is a very neat device which will be appreciate by a great many engineers.]

The Jeffrey Mfg. Co., Columbus, Ohio, U. S. A.=Catalogue 144 pp., 5″×7½″. [Describing chain belting, elevating, conveying, power transmission machinery, steam cable conveyors, labor saving appliances, etc. A very handsome catalogue well and profusely illustrated. Cover, pearl gray and blue.]

The Lackawanna Lubricating Co., Scranton, Pa., U. S. A.=Pamphlet unpaged, 7″×5⅜″. [Contains an Essay on Locomotive Cylinder Lubrication, with a description of the Cylinder Lubricators manufactured by this company. A full detailed description of the Lubricators, with engravings illustrating all their parts and their operation, is comprised in the pamphlet; also a certificate from the committee on science and the arts of the Franklin Institute, confirming the advantages of this lubricator and stating them in detail.]

William A. Nicholls, Philadelphia, Pa., U. S. A.=Pamphlet No. 7½″×10″, Pages not numbered. [Describes and illustrates the Barnes Portable Highway and Railroad Culverts. This culvert is built of steel or iron plates and shapes, with a trapezoidal cross-section, and angle iron bracing. The advantages are fully set forth in the pamphlet.]

Bayne, Wilson & Pratt, Pittsburgh, Pa., U. S. A.=Pamphlet 156 pp., 7″×10″. [Some Things That Have Been Written About Farrar & Treft's Machinery, Morris Tasker & Co.'s pipes, the Annealed Steel Coupling and the Palm Link, 1878-1895. [A reproduction of advertisements that have appeared in the *Bradford Era* and *Oil City Derrick* from 1878-1895, illustrated with portraits of many notable men, and also with comic illustrations which have accompanied the advertisements. The whole is printed on coated paper of good quality and handsomely bound in paper. Cover, pearl gray and brown.]

Sullivan Machinery Co., Chicago, Ill., U. S. A.=Catalogue, 80 pp., 7″×10″, 1894. [Describes and illustrates a great variety of the Sullivan diamond prospecting core drills. Full directions as to the erection and use of the machines are also supplied. A price-list is also comprised. Appended are descriptions of portable boilers, mounted on wheels, vertical boilers with submerged tubes, the "Eureka" sectional safety boiler, Blake steam pumps, Knowles' steam pumps, the Metropolitan Injector, for locomotive boilers, flue cleaners, portable forges, pipe-fitters' tools, coal-mining machinery, etc. This is a very fine catalogue indeed, well printed and illustrated. Cover, black and red.]

The Dunn Mfg. Co., Limited, Pittsburg, Pa., U. S. A.=Catalogue, unpaged, 6″×9″. [Describes and illustrates the extensible sewer brace manufactured by this company, and also a line of special tools for contractors' use. Cover, salmon-yellow and violet.]

The Cooper-Roberts Co., Mount Vernon, Ohio, U. S. A.=Catalogue 17 pp., 9″×6″. [Describing and illustrating the "Cooper" high speed self contained center-crank automatic engine, simple and compound; for electric light, street railway service, flouring mills, factories, &c.]

Sheffield Car Co., Three Rivers, Mich., U. S. A.=Catalogue, 96 pp., 6″×9″. [Describing a line of light cars and containing a full illustrated description of the works of the company. A very interesting catalogue, beautifully printed. Cover, robin's-egg blue and gold.]

The Hayden and Derby Manufacturing Co., New York, U. S. A.=Catalogue, 32 pp, 6″×9″. [Containing practical information about injectors, a few plain facts which are of interest to all steam-users, and illustrated descriptions of the injectors made by this company, including the Metropolitan Automatic Injectors described in full in the Department of Improved Machinery in the present number of this magazine.]

Joseph F. McCoy Co., New York. U. S. A.=Catalogue, 147 pp., 7″×10″, 1892. [Describes a long line of machinery and railroad specialties manufactured and sold by this company. The catalogue is excellently printed in blue, and the illustrations are very clear and neat. Cover, orange and black.]

The Standard Paint Co., New York, U. S. A.=Descriptive catalogue and price list, pages 9″×11¾″, unnumbered. [The text is interspersed with sheets of samples of the goods manufactured by this company, including high-grade building, sheathing, and insulating papers. These samples are for reference when specifications are drafted. The book is elegantly printed, and bound in stiff paper covers, blue and black.]

The Q. & C. Co., principal offices, Chicago, Ill., U. S. A., New York, U. S. A., and Montreal, P. Q., Can.=Catalogue, 32 pp., 7″×10″. [Describing a great variety of metal-sawing machinery designed and especially constructed and adapted to meet the requirements of steam railroads, street railways, bridge builders, structural iron works, rolling mills, shafting works, foundries, and all other users of metal, either cast or wrought iron or steel. Handsomely printed on coated paper, with *fin-de-siècle* covers.]

The Westinghouse Machine Co., Pittsburg, Pa, U. S. A.=(1) Pamphlet, 12 pp., 6″×3½″. [Economy vs. Guarantees of Engines. An essay intended to emphasize the question: "Which is most to your interest, a demonstration of true economy or an unfulfilled guarantee?"] (2) Pamphlet, 30 pp., 4½″×7″. [Practical Science, volume I, No. 1, devoted to the practical application of scientific electrical research. Price, $5.00 per year, 50 cts. a copy. A trade publication. This pamphlet, which is No. 1 of volume I of this trade publication, contains an essay on "Lightning Arresters, and Why They Sometimes Fail," by Alexander J. Wurts.]

The Prince Mfg. Co., New York, U. S. A.=Pamphlet, 32 pp., 5½″×9″. [The rusting of iron and steel, how it may be prevented, and how it is promoted; also Prince's Metallic Paint. Cover, robin's-egg blue.]

Purdue University.=Twelfth Annual Catalogue, 31 pp., 15½″×7¾″, 1895-1896.

Sulzer-Vogt Machine Co., Louisville, Ky., U. S. A.=Pamphlet, 20 pp., 6″×9″. [Describing and illustrating the electric elevators manufactured by this company. Cover, gray and blue.]

The Gould Coupler Co.=Catalogue 1893, 47 pp., 9″×12″, with supplement, 15 pp. [Contains a description of the Malleable Works of this company recently erected at Depew, N. Y., and also of the well known Gould's Steam Forge at Buffalo, N. Y., together with details of the various articles manufactured by this company. This is one of the handsomest catalogues that have recently come to our office. Printed on coated paper with ample and elegant illustrations, and bound in flexible covers, blue and gold. The supplement describes the Gould M. C. B. Freight Coupler, No. 8, Model of 1894; also the Gould M. C. B. Pilot Coupler and the Gould Freight Buffer, Model of 1894.]

W. D. Allen & Co., Chicago, Ill., U. S. A.= Catalogue No. 6, 240 pp., 6½″×10″, 1895. [Describes and illustrates an extensive line of rubber goods, including rubber belting, tools for belt work, belt clamps, rubber hose, etc., etc. Also an extensive line of leather belting, link belting, sprocket wheels, elevator machinery, steam and water fittings, engine governors, heating radiators, pulley blocks, tools and hardware, Babbitt metals, &c. This firm conducts the western salesroom of the New York Belting & Packing Co., Limited. Well printed and illustrated on good paper. Cover green and black.]

Campbell & Zell Co., Baltimore, Md., U. S. A.=How to Generate Steam Economically. A trade publication of 95 pp., 7″×10″, bound in stiff morocco. [The book discusses the principle of economical generation of steam, and also describes and illustrates minutely the Zell boiler with numerous illustrations of installments in important works. Numerous tables are presented, among which are a table of factors of evaporation, dimension tables of the boilers, table of percentage of fuel saved by heating feed water (steam at 60 pounds) size of chimneys for steam boilers of different rated powers, table of relative efficiency of non-conducting materials, etc.] (2) Leaflet entitled, "Some Little Things About Boilers," designed as a help in forming judgment as to the selection of boilers.]

The E. S. Greeley Co., New York, U. S. A.= Illustrated catalogue and price list, 560 pp., 6″×9″. [Describes and illustrates one of the most extensive lines of electrical supplies carried by any house in the world. It is significant of the extent of the growth of the electrical industries that a catalogue of this magnitude should be necessary to list the various appliances needed in them. Price lists accompany the descriptive text. Cover, buff and black.]

BOOKS RECEIVED.

Annual Report of the Board of Public Works of the city of Milwaukee, for the year ending December 31, 1894. Milwaukee: Ed. Keogh, 386-388 Broadway, 1895. [240 pp., 6″×9″, paper.]

Bulletin No. 9, United States Department of Agriculture, Division of Forestry. Report on the use of metal railroad ties and on preservative processes and metal tie plates for wooden ties. By E. E. Russell Tratman, A. M., Am. Soc. C. E. (Supplementary to Report on the Substitution of Metal for Wood in Railroad Ties, 1890.) Prepared under the direction of B. E. Fernow, chief of division of forestry. Published by authority of the secretary of agriculture, Washington: Government Printing Office, 1894. [363 pp., 6″×9″, paper.]

The Transit, volume 3, No. 1, January, 1895. Portland Cement. A monograph by Charles D. Jameson, Mem. Am. Soc. of C. E., professor of engineering, State University of Iowa, Iowa City. Published by the University of Iowa, 1895. [192 pp., 6″×9″, paper.]

Central Railway Club. Proceedings of the April meeting, 1895, held at the Hotel Iroquois, Buffalo, N. Y. Discussion and report of the committee on revision of the constitution and by-laws. Report of the committee on revision of the rules of interchange. [59 pp., 6″×9″, paper.]

Proceedings of the Electrical Society of Cornell University, 1894-1895, volume 2, Ithaca, N. Y.: Andrus & Church, 1895. [120 pp., 6½″×9½″, cloth.]

The Origins of Invention: a Study of Industry among Primitive Peoples. By Otis T. Mason, A. M., Ph. D., curator of the department of ethnology in the United States National Museum, Smithsonian Institution, Washington, D. C., U. S. A., with illustrations. London: Walter Scott, Ltd., Paternoster square. Imported by Charles Scribner's Sons, New York, 1895. [419 pp., 4¾″×7¼″. Cloth, price $1.25.]

On Bathing and Different Forms of Baths. By William Paul Gerhard, C. E., consulting engineer for sanitary works, author of "Hints on Drainage and Sewerage of Dwellings," "A Guide to Sanitary House Inspection," "House Drainage and Sanitary Plumbing," etc., Reprinted from *Architecture and Building*, New York: William T. Comstock, 1895. [31 pp., 6″×9″, paper.]

THE

ENGINEERING MAGAZINE

VOL. IX. AUGUST, 1895. NO. 5.

THE SIGNS OF THE TIMES.

By Edward Atkinson.

I HAVE been asked to call attention to some of the salient points in the present condition of affairs in this and other countries upon which one may base a long look ahead. Such forecasts are of no immediate application in the conduct of the daily or even the annual transactions of business men ; they are of no use to men of affairs who must watch the variations of each season and the temporary, but often very severe, checks to immediate progress. Commercial and financial crises, due to ordinary causes, affect immediate transactions, but few have any permanent influence. Legislative tampering with the currency, coupled with efforts to debase the unit of value, retard constructive enterprise and exert a disturbing influence of longer duration, but in a country of such unlimited productive power as our own the real forces on which material progress must be predicated are superior to these temporary aberrations, and in the end control events. We are now emerging from one of these malignant periods, but upon every side the evidence is plain that we have wrested benefits even from the hard times to which we have been subjected by the incapacity of congress. These benefits will have been gained at the cost of much individual distress, yet the nation has made a vast advance in productive energy, even in the last 2 years.

Few yet comprehend the meaning of the transfer of the paramount control of the production of iron and steel from European States to this country. The hard times of the last 2 years have rendered that control more absolute than it might have been except these hardships had been brought upon us.

Copyright, 1895, by the Engineering Magazine Company.

One writing for special readers, especially for engineers, may deal with this subject in a way that might not be interesting to the general public.

In 1890 I ventured upon a forecast of the production and consumption of iron in the year 1900 which has lately been treated as a very extravagant one. While I was engaged upon this work, Mr. A. S. Hewitt sent me an article written by himself in 1856, containing a forecast of the future which in 1890 had been even more than sustained. In that pamphlet Mr. Hewitt based his reasoning upon the following statement of the facts of that date,—1856.

> Assuming the population of the world to be 900,000,000, the production, and, of course, the consumption, of iron is at the rate of about 17 lbs. per head. In 1740, when we have the most reliable data, the consumption of iron did not amount to 1 lb. per head. But the great fact to which I wish to call your attention, in order to produce the practical results at which this paper aims, is the distribution of the present consumption among the nations of the world. In order to determine this point, I have made very careful calculations, which show the following result :

Nations.	Production per head.	Consumption per head.
England	287 lbs.	144 lbs.
United States	84 "	117 "
France	40 "	60 "
Sweden and Norway	92 "	30 "
Belgium	136 "	70 "
Austria	12½ lbs.	15 "
Russia	10 lbs.	10 "
Switzerland		22 "
Prussia	50 "	50 "
Germany, Zoll Verein	50 "	50 "
Spain	4½ lbs.	5 "

> Turkey and the uncivilized portions of the world too little to be calculated.

Upon these facts Mr. Hewitt predicated his forecast, calling attention to their meaning in the following terms :

> A careful examination of this table will demonstrate conclusively that the consumption of iron is a social barometer by which to estimate the relative height of civilization among nations ; for, considering in what practical civilization consists (I exclude esthetic civilization from this species of estimates), measuring by the actual comforts and conveniences with which social life is surrounded, what philosophic traveler or student will not classify the nations of the world precisely as the table arranges them : England first, United States second, Belgium third, France fourth, Germany fifth, Switzerland and Sweden about on a par, Austria next, then Russia, Spain, and Turkey, and the great outlying regions of barbarism ? You will not fail to observe another fact,—that the large consumers are large producers in every case,—a fact which a little familiarity with the laws of trade and industry will show to be inevitable.

Without any previous knowledge of Mr. Hewitt's analysis, the writer had made the following analysis of the consumption of iron, which is a better social standard or barometer, because its production is not a very desirable occupation. It is, however, true that the production in greatest measure leads to the largest consumption. It is therefore a necessary factor in the subsequent analysis.

CONSUMPTION OF IRON, 1870 to 1890.

In 1870 to 1878, inclusive, the average consumption of iron per capita by the people of the United States, as nearly as it can be computed, did not exceed	150 lbs.
In 1879, taken separately, it was approximately	200 "
In 1889 it was in excess of	300 "
In 1889 the consumption or use of iron in Great Britain, France, Germany, and Belgium, after making allowance for the relative import and export of each country, did not exceed per capita	175 "
If there were upon the globe in 1889 about 1,200,000,000 people aside from the population of the foregoing countries, then their average consumption of iron did not exceed per capita	11 to 12 "

From the authorities consulted it would appear that the production of the United States, Great Britain, France, Germany, and Belgium has long been approximately a little over 90 per cent. of the commercial iron product of the world. The product of these specific countries was substantially as follows:

1856	6,000,000	gross tons
1867	8,400,000	" "
1878	12,750,000	" "
1889	22,800,000	" "

The price of anthracite foundry iron in Philadelphia was as follows:

1856	$27 1-8	net ton, in gold.
1867	44 1-8	" " " currency.
1878	17 5-8	" " " gold (practically).
1889	17 3-4	" " " "

It will be observed that the increase in production from

1856 to 1867 on rising prices was	40 per cent.
1867 to 1878 on declining prices was	50 " "
1878 to 1889 on variable, but generally lessening, prices was	80 " "

These facts make it apparent that, in spite of lessening or variable prices, the great improvements which have been applied to the science of iron-making have enabled the owners and managers of mines and works to meet the accelerating increase of demand, notwithstanding the great advance in wages both in Europe and in the United States between 1856 and 1889.

Summary of consumption in round figures and gross tons in the year 1889.*

---

* This estimate was based upon the actuarial computation of the population of the United States in 1890 before the census had been taken. Were the census figures used as a divisor, the per capita consumption of iron would appear to have been a little more. My own judgment has always been that the actuarial computation was probably nearer the mark than the actual enumeration, there appearing to be no sound reason for the abnormal retardation of the increase of population between 1880 and 1890.

	Population.	Per Capita.	Tons.
United States	64,000,000	300 lbs.	8,500,000
Great Britain, France, Germany, and Belgium	136,000,000	175 "	10,500,000
All the rest	1,200,000,000	11 "	6,000,000
Total	1,400,000,000	40 lbs.	25,000,000

Upon that analysis the writer based his forecast of 1890, which is even more applicable to the present time when we are emerging from the period of temporary retardation in our progress, in which the consumption of iron has been reduced. With some slight changes the argument of 1890 will now be repeated.

The conversion of iron into railroads and steamships and the opening of commerce and the development of industry in specified countries, coupled with the increase of commerce between countries now connected by railroad and steamship more intimately than ever before, while creating an enormous primary demand for iron and steel in laying the railroad and building the ships, yet develops a constantly increasing secondary demand for iron and steel for other uses, —*i. e.*, for structural purposes, stationary engines, machinery, and tools of every name and nature. Thus it happens that, while the development of the ways of commerce has, at the beginning, created an enormous demand for iron and steel, subject to considerable fluctuation according to the activity or depression in constructing railroads or vessels, yet, in the last 2 years (1888 and 1889) in which the construction of railroads lessened in comparison with the immediately preceding period, especially in the United States, the increase of the demand for iron for other purposes (now, 1895, including electric railways) has more than counterbalanced the diminishing demand for that purpose, and the advancing tendency of prices on what may be called the normal demand of the world has very lately been developed.

Let us then put questions in regard to the future status of each of the great sections of the world included in the above table. Who will answer them?

In respect to the United States, is it not almost certain that the consumption of iron will go on increasing, subject to temporary variations, in the period which will elapse between 1890 and 1900,—not only in the present ratio to the population, but also in an accumulative measure corresponding to the increase per capita which was developed between 1877 and 1889? Let it, however, be assumed that the increase per capita will rise only from 300 to 400 lbs. per head; then the 80,000,000 of people who will occupy this country in the year 1900 may require, in addition to our present supply, not less than 7,000,000 gross tons.

If the demand of Great Britain, France, Germany, and Belgium shall increase only 20 per cent. in the next 10 years,—1890 to 1900, —that increase will create a demand, in addition to their present consumption, for 2,000,000 tons.

If the consumption of the rest of Europe, of Asia, of Africa, of South and Central America, and of Australia shall carry their demand only from 11 or 12 lbs. per capita to 22 or 24 lbs., then, in addition to their present supply of 6,000,000 tons, they would require 6,000,000 more.

A summary of these conclusions will make the prospective demand of the world in the year 1900 stand as follows:

Present production (1890) based on the figures of 1889		25,000,000 tons.
Increased consumption in the United States	7,000,000	
Increased consumption in Great Britain, France, Germany, and Belgium	2,000,000	
Increased consumption in all the rest of the world	6,000,000	
Total increase of demand		15,000,000 "
Total supply required in the year 1900		40,000,000 tons.

This forecast of 1890 of an accelerating demand far beyond the increase of population was justified by the conditions of the years 1891 and 1892, but the financial panic of 1893, due to the attack upon the credit of the country and the threatened debasement of the unit of value, almost stopped constructive enterprises. The reduced consumption of iron in 1893 and 1894 bears witness to the social disorder which ensued, fully justifying Mr. Hewitt's measure of the importance of this social barometer. We are now emerging from that period of disaster, and constructive enterprise is now being resumed.

Although the demand for iron and steel for railway construction is relatively less important than it was in the periods previously dealt with, it is yet a factor which calls for separate treatment.

In 1881 the writer dealt with the standard of adequate railroad service. At that time the unit chosen was the mileage of Massachusetts, possessing within her area 1 linear mile of railroad to each 4 sq. miles of territory,—all save one small section of this mileage then and subsequently profitable both to their owners and to the State. Taking that unit as the standard of adequate service, the territory of the United States was divided into several sections, and, forecasting their need down to the year 1900 from January 1, 1880, the requirements of the several sections were put as follows:

Section No. 1, 1 mile of railroad to 4 sq. miles.
No. 2, 1 to 8.

No. 3, 1 to 16.
No. 4, 1 to 32.
No. 5, 1 to 64.
No. 6, indefinite.

Upon that basis the future requirement of railroads starting with a little under 93,000 miles in service called for 117,000 miles to be added by January 1, 1900. The average from January 1, 1880, to January 1, 1893,—13 years,—exceeded the estimate, being about 6400 miles a year. In 1893 and 1894 the silver agitation stopped the necessary construction of railroads, with the effect that in 2 years we have not added as many as ought to have been added in 1 year to meet an absolutely necessary demand. Yet, adding these 2 years of disaster, and computing the miles of railroad in operation January 1, 1895, at 180,000 as compared with January 1, 1880, 93,000, the forecast of 1881 has been justified. It is not improbable that the 30,000 miles called for to meet the needs of the country January 1, 1900, will yet be added, bringing the mileage on January 1, 1900, to about 210,000. Basing our anticipations from January 1, 1896, it may be remarked that future construction will be on a cash basis, not on a speculative or inflated basis, and that by so much as railroad construction has been retarded in the last 2 years may it be accelerated in the next 2 years; subsequently construction will go on at a normal rate.

A very large addition to the railroad service is now projected. How much the increase may be in the present calendar year (1895) does not yet appear. It does appear, however, that in the next year the average of the last 15 years of about 6000 miles per annum may be renewed, especially in the States and territories from which capital has been excluded for several years by the discredit due to congressional action. Taking Texas as an example, there is no reason why that State should not rapidly approach the railroad mileage of other sections in the middle West less well endowed with resources. That would require 40,000 miles of railroad in that one State, which now has less than 10,000. The causes of discredit and the distrust of the people of Texas will presently be removed by ejecting from congress their misrepresentatives who have tampered with the unit of value. Alabama is a very productive State, where railroad construction has been retarded; her people are moving upon the same lines. Georgia has not been so much discredited, but needs to take the same action. Yet more, States and territories in the far West—Oregon, Washington, Montana, and Idaho—will presently eject from congress men who have discredited their States, and among them will be the senator who made the unblushing avowal to the writer, when a protest was entered against his action on the free coinage of silver: "Of course I know better. I don't believe all the d—d rot, but I have got to vote for it."

The more probable course of political events will be that, under the impulse of the prosperous conditions which are now in sight, men of ability, as some of these misrepresentatives are, will see the error of their ways, and will sustain sound-money measures, leaving the little faction from the silver mining camps to save themselves from derision as well as they can.

It therefore follows that, dating from January 1, 1896, it will become necessary to add railroad mileage to our present service at the rate of not less than 5000 or 6000 miles a year for many years to come, in order to give a partly adequate service to these very productive areas of our national domain which are now suffering from their own discredit. Not less than 100,000 miles of new railroad must be constructed in the next 15 or 20 years.

This extension will not consist of great through lines, which may be called the warp of our system, but of cross lines and connections, which make the weft. Bearing in mind the relative resources of the two sections, one may contrast the present totally inadequate railroad service of Texas of less than 10,000 miles with that of an area but a trifle greater in the States of Ohio, Indiana, Illinois, Iowa, and Kansas, which have 44,000 miles.

On the other hand, the demand upon the iron and steel furnaces for rails for new railroads is no longer the most important factor. At the lessened prices of steel the demand for the purpose of constructing buildings and for many other kinds of work in which wood and other materials have been used is becoming the paramount factor. The rule of accelerated demand out of all proportion to increase of population is now more potent and subject to more rapid development than ever before. That rule is affecting the consumption of all nations.

Where will this increasing demand be met? Great Britain has depended mainly for fine or bessemer metal upon the ores of Spain, near Bilbao, where the deposit is nearly exhausted. Her supply of coking coal is lessening, and the cost is increasing. When her furnaces depend upon the ores of Africa, the South of Spain, and the Arctic regions of Sweden, the haul of ores to the furnaces will be more costly than from our Lake Superior mines to the lake ports or to Pittsburg. Our supply of coke is in excess of any possible demand; it is produced at much higher wages and at half the cost of British coke, mining and handling requiring very much less labor.

We may also anticipate a very great increase in the consumption of iron and steel in the construction of vessels. There have been two causes for the relative increase of British naval construction and the reduction of our own. We had the advantage in building ships of timber. Subsequently iron and then steel ships took the place of wooden vessels. The disparity in the price of crude iron between this country and Great Britain, down to a very recent period and for a long term of years, averaged $7 per ton. This disparity was caused by duties on imports, but was somewhat less than the rates of duty, yet more than sufficient to protect the British ship-builders and forbid competition here. Our present duties have become inoperative, since we now produce iron and steel in many places at a less cost than in Europe; the advantages which we possess in other directions will presently turn a large part of the construction of ships to this country.

One obstruction is yet to be removed,—to wit, the duty on the bessemer ores of Cuba and on the coal and scrap iron on which New England formerly depended in many works before her iron industry had been destroyed by our tariff policy; this change will remove our only present disadvantage in the construction of vessels for ocean service. Our ships of war, especially the naval vessels which bear the disgraceful name of "Commerce Destroyers," have given evidence of the capacity of our ship-builders to master the principles of construction coupled with high speed. When that skill is devoted to the protection of commerce, to which the barbarous conception of destroying commerce must give way, we may resume our due proportion in this branch of productive work, but we shall not attain full supremacy until the second obstruction is removed,—namely, the obsolete, but onerous, provisions of our navigation acts.

The domestic consumption of iron is now estimated at approximately 350 lbs. per head, justifying the forecast of 1890. The population at the present time is, in round figures, 70,000,000. At 350 lbs. per head the requirements for the next 12 months would be within a fraction of 11,000,000 gross tons,—a little over 12,000,000 net tons. One-eighth of our consumption, however, is derived from old scrap iron and steel, old rails, car-wheels, etc. This will reduce the demand upon iron furnaces to about 9,500,000 gross tons, or a little over 300 lbs. per head of new iron.

I should not myself have ventured to put the present consumption quite so high, but I am permitted to cite the authority of Mr. James M. Swank, the able secretary of the Iron and Steel Association, on this point.

A few words may be given to the consumption of other countries. The financial difficulties which have affected Australia and South America have exerted a very adverse influence upon the demand for British and German iron. These financial difficulties are now being surmounted, and a new start has been given to the productive energy of the Argentine and other South American countries and to the colonies of Australia. To their demand will be added that of Africa, and especially of South Africa, which is now making such rapid development. It is not probable that there will be any considerable increase in the per capita consumption of iron in England or in continental States. The burden of passive war and the heavy taxes imposed for the support of armies forbid any considerable industrial progress, while on the continent of Europe, with the development of the land armaments, it is becoming manifest that the battle-ships and other armed ships of war, so many of which have lately been on review at Kiel, are practically worthless for offense or defense, and may soon be concealed in the grave-yards of iron-clads corresponding to the harbor of Bermuda, where there is already a great collection of iron-clads of the type of a few years since. Where the Germans, French, and Italians may hide their examples of ignorant and wasteful expenditure on these lines is not yet manifest.

There is something rather grotesque in the picture which the nations have made at the opening of the ship-canal at Kiel. The object of that canal is mainly to promote commerce, to facilitate exchange, to bring to the occupants of a rather poor soil in middle Europe a necessary supply of food and fibres from other parts of the world, and also a necessary supply of the crude products of the non-machine-using nations for conversion into finished goods for home use and export. In order to celebrate the opening of this peaceful way for commerce, there gathered a collection of naval bull-dogs, each for the time muzzled, but in many instances with growl barely suppressed. In a rough-and-ready way one may estimate the cost of this fleet of 100 great armor-clad ships of war, with 25 lesser vessels, at approximately $200,000,000, which is probably four or five times the cost of the peaceful water-way the opening of which they were called together to celebrate. The United States was represented by one battle-ship and, I believe, by one of our two "Commerce Destroyers," so-called. The two armored ships so named cost nearly $7,000,000,—a sum nearly equal to the entire endowment of Harvard University,—while the annual expense of keeping the two in commission is nearly as great as the pay-roll of the same University. The only commerce of any importance upon which these destructive ships of war could exert their force would be that of Great Britain and Germany, our two largest foreign customers for the excess of our farm products, which would rot upon our fields if we could not sell them for export. Any commentary upon these grotesque conditions would perhaps be superfluous.

In striking contrast to the demonstrations at the opening of this canal, one may refer to the canal at St. Mary's falls through which the commerce of the great lakes passes to the Welland canal and to the superfluous canal which Canada has just constructed nearly parallel to our canal on the other side of the way. The annual tonnage passing through the St. Mary's canal connecting our great lakes exceeds that which passes through the Suez canal every year by more than 25 per cent. Neither of these canals is guarded by forts or armor-clad vessels; the simple agreement entered into by President Monroe and the British government in 1818 forbids the construction of any ships of war upon the great lakes. That is a true Monroe doctrine, which the Jingo element in our politics might well regard. The purpose of that agreement, as distinctly stated on both sides, was "to avoid collision and to save expense." Not a word may be said against the construction of a few swift cruisers to protect the commerce of the United States in distant places. Such vessels although armed, are entitled to the name of "Commerce Protectors."

As time goes on, this waste of preparation for war will be stopped in more than one way.

First, because no ship can carry armor which will defend it from the latest type of guns.

Next, because no land force can stand in the face of guns discharging over six hundred shots per minute warranted to kill at more than a mile.

But lastly, as to European States, because the limit of taxation has been reached. New taxes cannot be invented, and new sources of revenue cannot be discovered, which will warrant even the maintenance of existing armies and navies. The burden of militarism is borne mainly by the machine-using nations and States of Europe, with which this country is about to enter into more urgent competition than ever before. The only group of machine-using nations which now has any chance of success in competing with this country, either in supplying us with any of the manufactured goods that we require or in supplying other nations with the useful products of machinery, consists of Great Britain, the Netherlands, Germany, and France. Their ability to compete may be measured by their relative consumption of iron; their inability to compete may be measured by the burden of the withdrawal of men from useful service to fill the camps and barracks where they are supported each by the labor of another and by the unbearable burden of taxation which can no longer be safely borne.

All modern commerce rests upon a fraction of profit on each unit of product. In that nation, State, or section in which skilled labor is applied to the use of machinery under the safest conditions the product will be greatest, the price of the product will be lowest, and the wages of workmen will be the highest. These are correlative terms, each the complement of the other. The burden of taxation then comes in. It is to be measured, not by its ratio to the gross cost of the thing taxed, but by its ratio to the lessening margin of profit by which production is induced. So far as I have been able to investigate this somewhat obscure subject, the tax imposed by this country for all national purposes at the present time does not exceed 2½ per cent. upon our product. That of Great Britain is more than 6 per cent. That of the Netherlands, France, and Germany is more than 10 per cent. That of Italy, which I have not yet named, takes so large a share of the product as to have reduced some sections of the country to conditions of disease merely for lack of suitable food. That is the price paid by nations in order to enable them to send $200,000,000 worth of useless and worthless armored vessels to celebrate the opening of a peaceful canal.

The subject of relative taxation in proportion to the product is one to which I can only refer in preparing the conclusion of this treatise on the "Signs of the Times."

It may be remarked that, if these ratios of the relative burden of taxation to profits, which I believe to show much less than the real advantage of this country, are sustained by the facts, their import is profound. This country is the only machine-using nation which produces food, fuel, metals, and fibres far in excess of its own wants. If to that advantage is added a difference in the burden of national taxation corresponding to the previous figures, there can be no competition on the part of other countries with this country in making any products, except those that depend either upon fashion and fancy for their sale or upon the skill of the handicraftsman for their production. These fabrics are relatively unimportant and insignificant in comparison with the great mass of useful goods which the world is calling for in increasing quantity. Capital has accumulated in recent years faster than ever before, especially in this country. Anything that shows a gross profit of 10 per cent. would be instantly taken up by capitalists for development. Therefore, when useful goods show a profit of 10 per cent., free of national taxation, the ratio of our national taxes to that profit is two and a half to ten; in Great Britain, at least six to ten; in France and Germany, ten to ten. That is to say, our rate of national taxation takes only two and a half parts from a gross profit of ten; other things being equal, the British national taxation takes six parts from ten; in France and Germany national taxation takes the whole. But other things are not equal; the advantage is with us. Manifestly the capital and the skilled workmen will tend year by year to that section of country in which the highest wages can be earned by converting the greatest abundance of crude products into finished goods under the least burden of national taxation. Yet Great Britain will retain her supremacy in manufactures and commerce if she maintains her standard or unit of value, the pound sterling, and we do not maintain our own. When we surely establish the unit of value in this country so as to give equal confidence in its maintenance and in its integrity, we shall assume our paramount position in the production and distribution of all useful fabrics. Possessing, as we do, the power to produce food, fuel, fibres, and metals in excess of all our wants ; enjoying absolute free trade on a continental scale over a larger area and among a greater number of people than ever before secured that great advantage ; and holding the control and use of practically unlimited supplies of the ores of iron and copper upon which the commercial world must soon rest for its principal supply of these metals,—our dominion is established.

Motley tells the story of the people of the Dutch Republic, who, producing not a grain of wheat within their borders, ate the whitest bread of Europe. Even so the people of this republic would command the treasures of the world, though not an ounce of gold had been found in any part of our domain. While Europe is ruled by "blood and iron," we may hold a pure control over all nations in the pursuits of peace and welfare by the use of our iron, and yet not shed one drop of blood.

Ense petit placidam sub libertate quietem.

THE TROLLEY IN COMPETITION WITH RAILROADS.

By Clarence Deming.

ADDED to causes more obvious and general have been special ones, both physical and economic, which have made Connecticut an alluring field for electric enterprise. The State itself, abounding in surplus capital, albeit somewhat conservative, lies between and near New York and Boston, open to the overflow of investment funds from those money centres and without that drawback of remoteness in the financial venture which of late years has been checking the westward flow of eastern capital. There are eighteen cities in the commonwealth, containing probably not less than 65 per cent. of the population. Of those eighteen cities fifteen are in five of the eight counties. Three counties—New Haven, Hartford, and Fairfield—included by the last census about 68 per cent. of the total population, and have a still larger portion to-day. Testing still farther the urban centrality of population which favors the development of transit systems, it will be found that the maximum distance from any Connecticut city to the city proximate is between Danbury and Norwalk,—about 23 miles by rail,—while, as a measure of minimum inter-urban distance Norwalk forms physically one city with South Norwalk, as does Ansonia with Derby. A population of more than 200,000 fringes the shore for about 45 miles between Greenwich and New Haven, and between the latter city and Hartford, both inclusive, a population almost as large dwells along an interior straight line of some 36 miles. There are, outside of the cities, twenty-one borough towns, ranging from 2235 to 10,131 in population, and all through the State prevails the familiar New England drift from the country regions to the city or factory town. The thickly-settled factory valleys of the interior and the level areas of lower Connecticut offer easy grades for railroad construction. If we consider all these conditions, we find that no American State, with the possible exception of New Jersey, has offered a more attractive natural field than Connecticut for electrical venture.

The obstacles to the trolley in the State have been twofold: first, that tenacity of property rights so marked in New England communities, and revealed in Connecticut, not so much in the cities, as in the opposition to the surrender of the highways outside of them; second, and of much greater moment, the resistance of the steam-railroad corporations, which own or control properties representing not less than $200,000,000 at present market values. How paramount in the State legislature has been the highly-organized lobby of the New York, New Haven and Hartford (the "Consolidated") railroad company is too trite a fact to need fresh description. But as an exponent of the general as well as localized powers, at the State capitol, of the Connecticut steam-railroad corporations, it may be stated that, out of 168 townships in the State, 135 are bisected by one or more lines of steam railroad. Except one short line of a semi-private character and the New London Northern road, which is allied with the Vermont Central system, the Consolidated and the New York and New England Company own or control every mile of steam-railroad track in Connecticut, besides two of the great lines of Sound steamboats with terminals in the State. If the Consolidated Company alone, often with the New England Company as a foe, has been all but able to dominate legislation, one can imagine the influence at the State capitol of all the steam companies when joined together against electric innovation when it has menaced their interests. The conflicts of the two have made Connecticut a battle-ground of the rival systems.

Connecticut legislation has been so serious in its bearings on the trolley roads that a brief sketch of it, up to and including 1893, is timely, the general work of the present legislature being left for later review in this article. Before 1890 there had been but two experiments in electric transit, both on short local lines with clumsy equipment. They were not popular, and later reports of the "trolley nuisance" from outside cities intensified the dislike. As a sample of the popular feeling, the promoters of a new street railroad in New Haven, seeking a charter from the legislature of 1889, could obtain it only by inserting a special proviso against electrical equipment. But the future of electricity was forecast, and a large number of new projects awaited the authority of the next legislature of 1891,—so many that, when the partisan deadlock which made the session a blank began in that year, it was predicted freely that the electrical interests would force a settlement. But no settlement was made, and the effect of the legislative *hiatus* of 2 years was to mass new enterprises for the next general assembly,—that of 1893,—on which they descended in a flood. They were resisted stoutly by the steam companies, but, by alliance with the "granger" element in the lower house, won a victory—on a question of the powers of the railroad commission over new trolley projects—which forced, as a compromise, the general electric law now on the statute-books of the State. Its most salient provisions are: (1) local control—by mayors and common councils in cities, wardens and burgesses in boroughs, and selectmen in towns—

of layout, track, speed, and equipment of electric roads; (2) compulsory maintenance by the company of the street between tracks and of 2 ft. on each side; (3) right to carry both passengers and freight on approval of the superior court; (4) parallels of steam roads to be amenable to the same jurisdiction—with power of appeal on questions of law to the supreme court; (5) towns, cities, and boroughs, as well as the companies, to be liable in certain cases for damages; (6) the word "street" to include bridges; (7) registration of all bonds with the State comptroller, and bonding to be limited to three-quarters the cost of construction and equipment, this clause, however, allowing special charters to override the bonding safeguard, and thus giving rise to dangers which have been realized; (8) compulsory exchange of traffic under orders of the courts; and (9) annual returns to the State railroad commission. By a statutory flaw, however, returns were ordered on October 1 of each year up to and including the day before. This has essentially nullified the provision of the statute for returns, and made a travesty of many of such returns as have been handed in; and in consequence there are now few trustworthy official statistics of Connecticut street railroads and no official compilations.

The legislature of 1889 passed a bill which prohibited grade-crossings of steam railroads by horse, cable, and electric roads. But in the next working legislature of 1893—the deadlock having intervened—the electric companies secured a modification of the law, so as to legalize those crossings, if approved by the railroad commission. That body, which, from the first, had opposed the crossings, while allowing them in some cases, took a rather resistive attitude. Then a long and sharp legal contest ensued over the question of the right of electric companies which by charter had been granted the special privilege to cross at grade to override the general law. In the test case—that of the Bridgeport Traction Company against the Consolidated Company, involving a very dangerous grade-crossing at Bridgeport—the latter corporation won in the lower court, but, by a divided bench of three judges to two, was defeated on appeal, one of the points raised being the priority in time of operation of the charters as against the general statute. Meanwhile great popular opposition had arisen against grade-crossings of steam and electric roads, and at the end there was a kind of race between the legislature and the traction company, which needed the court's final order before laying its rails. The legislature won; a terse bill absolutely prohibiting grade crossings was literally "railroaded" through the general assembly, and is the law to-day. Though popular and justified, the new statute favors plainly the steam companies with their established lines, and it is predicted that in certain cases, by laying short spur tracks from their lines, they may be able to pervert to their own vantage as against trolley parallels the benefits derived from the new prohibitory statute.

While, owing chiefly to the legislative deadlock, the period of active electrical expansion has spanned but a little more than 29 months, the statistics of growth are impressive. In January of 1893 there was in single track a total of 147 miles (approximately) of street railroad in the State, of which about 81 miles were operated by horse power and 66 miles by electricity. There are now about 289.7 miles, of which all but two short roads with some 5 miles of track are electrically equipped. A list of the separate roads, companies, and systems is exceedingly difficult to compile, owing to the rapid changes; but, so far as such a list can be made from the supplement of the *Street-Railway Journal*, with some additions, it is annexed:

	Single track miles.
Bridgeport Traction Co	45.0
Danbury and Bethel	7.2
Derby Street Railway Co	.50
Hartford Street Railway Co	35.0
Hartford and West Hartford	14.0
Meriden Railroad Co	17.0
Middletown Railroad Co	4.5
Central R. R. and Traction Co. (New Britain)	12.0
Fair Haven and Westville	15.4
New Haven and Centreville	2.7
New Haven Street Railway Co	21.8
Winchester Avenue	16.4
West Shore	3.8
New London Street Railroad Co	7.2
Norwalk Street R. R. Co	5.0
Norwalk Tramway Co	12.5
Norwich Street R. R. Co	12.5
Southington and Plantsville	1.8
Stamford Street R. R	7.0
Waterbury Traction Co	11.0
Westport and Saugatuck	1.7
Hartford, Manchester and Rockville	16.0
Hartford and Poquannock	10.0
Bristol and Plainville (in construction)	4.5
Total	289.7

Actual investment in street-railway properties of the State it is impossible to compute. The latest statements of the corporations show roughly an issued capital stock of $8,566,000, and bonded debt of about $6,662,000. But, owing to stock inflation, the actual investment is far below the total ($15,228,000) of the two. The old roads, when electrically equipped, have shown the wonted increase of business. For example, one important line, on an increase of mileage of

57 per cent., returns for 1894 (electric) over 1893 (horse) a gain of 72 per cent. in gross earnings; another line, of about 12.5 miles, shows, with an increased mileage of 14 per cent., a gain of 81 per cent. in 1895 (electric) over 1894 (horse); while a small road shows for the same years a gain of more than 100 per cent. for electricity, with an increased mileage of but 29 per cent.

The figures for total mileage in the State show about 97 per cent. increase in single-track miles within the period of 29 months. In January of 1893 there were twenty-two distinct street-railroad corporations operating their lines. There are now not more than 24, although single-track mileage has increased 97 per cent., showing the swift process of both extension and absorption which has followed the introduction of the trolley. The increase in not a few cases has been too speculative. New roads too often have been built, crudely and crudely equipped, "financed" on bonds under "special" charters, while the stock has been held with partial or even no payments at all, and to a degree the first impacts of the trolley, under the auspices of foreign capital, have duplicated the kiting epoch of steam-railroad building brought to so disastrous a climax in 1873. To these reasons for financial and popular criticism have been added the hawking of charters and a tendency to "grab" streets, to invade municipal politics, and to tamper with city councils. But, despite these flaws of character and conduct, the new motive power has enjoyed a high popularity that is still rising. Speed, odors diminished if not eradicated, no stress of horseflesh, comparative smoothness of operation, may merely be named here as factors of popularity not limited to Connecticut, and to which may be added, as a more localized element, a large immunity from accidents, either serious or many, to be charged, perhaps, to good luck rather than to conservatism.

Of "projected" trolley roads—using the quoted word in its most ample sense, from actual layout to speculative hope—there are about forty-one enterprises in the State, reaching over some 381 miles of single track, some of them extensions. A good many of them have been smitten hard in the present legislature, but a system which contemplates a new mileage about 32 per cent. larger than that of all the street railroads already built in the State can be pruned much and still be portentous. In view of its size and ambitions, perhaps the organized resistance of the steam companies in the lobby and their sway over the legislature, while revolting to the ideals of representative citizenship, have not been unmixed evils.

The effect of trolley roads in the State as parallels of the steam lines is a subject upon which clearer light is thrown than on some other phases of the steam-trolley problem. Counsel of the Consolidated road has presented at a committee hearing in Hartford the annexed figures of loss in number of passengers for the two periods of 6 months each, ended with February of 1894 and February of 1895, to show the effect of parallel competition up to that time :

					Decrease.		
			1894.	1895.	Number.	Per cent.	Miles.
Bridgeport	and	Stratford	23,547	7068	16,479	.6998	3.2
New Haven	"	West Haven	8234	6649	1585	.1925	2.4
New Haven	"	East Haven	5619	2203	3416	.6080	6.0
Meriden	"	Yalesville	13,768	3002	10,766	.7810	3.0
Hartford	"	Rocky Hill	7558	6567	991	.1300	9.0
Union City	"	Waterbury	23,124	3107	20,017	.8657	4.0
Naugatuck	"	Waterbury	48,672	6051	42,621	.8757	5.0
New Haven	"	Woodmont	8580	3275	5305	.6183	6.4
Bridgeport	"	Southport	20,748	15,617	5131	.2473	6.6
Meriden	"	Wallingford	34,237	24,548	9689	.2830	6.0
So. Norwalk	"	Rowayton	33,606	21,814	11,792	.3509	2.1
So. Norwalk	"	Winnipauk	808	102	706	.8738	3.2
Derby	"	Ansonia	2479	2225	254	.1025	1.9
Birmingham	"	Ansonia	12,020	10,400	1620	.1348	1.9
		Total,	243,000	112,628	130,372	.5365	

Between Bridgeport and Fairfield (5.1 miles), for December, January, and February of the 2 years, the following figures were also supplied :

	1894.	1895.	Decrease.	Per cent.
December	5224	3598	1626	.3113
January	4601	977	3624	.7877
February	3940	903	3037	.7709
Total	13,765	5478	8287	.6005

Between Danbury and Bethel (3 miles) the following were the returns for 2 months :

	1894.	1895.	Decrease.	Per cent.
January	4698	2906	1792	.3814
February	7251	1401	5850	.8067
Total	11,949	4307	7642	.6400

The whole number of passengers for the stated periods of 1894 in the foregoing tables was 268,714 on about 55 miles (allowing for duplications) of the Consolidated road, and the decrease due to about the same total distance of trolley parallels was 146,301, or a little more than 54 per cent. Carrying out the ratios so as to obtain a full year's computation, the loss of the Consolidated Company would be represented by 339,744 passengers. The figures look large, but are not so impressive when reduced to dollars in the table following, where the liberal estimate is made of 2¼ cents loss per passenger per mile :

			Loss for the year.
Bridgeport	and	Stratford	$2,373
New Haven	"	West Haven	171
New Haven	"	East Haven	922
Meriden	"	Yalesville	1,453
Hartford	"	Rocky Hill	401
Union City	"	Waterbury	3,603
Naugatuck	"	Waterbury	9,589
New Haven	"	Woodmont	1,527
Bridgeport	"	Southport	1,523
Meriden	"	Wallingford	2,616
So. Norwalk	"	Rowayton	1,114
So. Norwalk	"	Winnipauk	101
Derby	"	Ansonia	23
Birmingham	"	Ansonia	148
Bridgeport	"	Fairfield	3,803
Danbury	"	Bethel	3,094
Total			$32,461

The loss of $32,461 is partly offset by the economies of steam service represented by the withdrawal of one train between Waterbury and Naugatuck, and probably much further by additional business fed the steam road by lateral trolleys; and even the parallels must also have contributed something to general business to partly offset their competition. But, taking the sum as it stands, it represents but about $\frac{1}{8}$ per cent. of the gross receipts ($25,576,884) of the Consolidated Company's whole system in four States. At the same time it is to be remembered that the loss by immediate competition tends to increase, and that Connecticut losses of the Consolidated Company represent but a part of the total which has its larger fractions in Massachusetts and suburban New York. In closing this statistical branch of the subject, it may be noted that operated trolleys now paralleling steam roads in the State represent a total of about 91 miles. Their effect as rivals is naturally much less marked in cases where old roads have been equipped with electricity than in those where new roads have been built.

The possibilities of electric rivalry with steam roads in the State open a wide realm for prophecy and speculation. The Consolidated corporation's managers undoubtedly dread less the merely local competition than the future welding of links of electric parallels into a single long parallel with threatened rivalry on distant business, especially in freights. The most sagacious opinion inclines to the belief that the immediate competition between proximate stations will hardly grow into serious rivalry between intermediate ones, and that the trolley as a parallel and competitor will presently be succeeded and offset by the trolley as a lateral and feeder.

Since the opening of the present year the story of the campaign of steam against the trolley has been both in the courts and the legislature a well-nigh unbroken set of reverses for the electric companies. In the superior court, on the 10th of last April, Judge Hall made a most important ruling on the application of the New Britain Central Railroad and Electric Company to build a trolley line between that city (of about 22,000 inhabitants) and Hartford, some 9 miles distant. The case fell under the provision of the General Electric railroad law, which forbids a line parallel to a steam road unless the projectors shall have satisfied a superior court judge of its public necessity and convenience. In this case there can be no doubt that the new line would have been well patronized, though it paralleled pretty closely the New England and the Consolidated, which run many trains between New Britain and Hartford. Yet Judge Hall found against it on the question of fact, holding, apparently, that the rule of public convenience and necessity applied with equal force whether a trolley company owns its roadbed or is laid upon a highway, and that upon the street railway rests the burden of proof. As the steam companies claim unlimited power to multiply trains, especially if equipped hereafter with trolleys, this burden of proof may prove an obstinate barrier to parallel trolley enterprises, if Judge Hall's opinion prevails.

But it has been in the present legislature that electricity has met its most serious defeats. Under adverse committee reports parallel after parallel has been thrown out, including a projected line from Newington to Hartford, an extension of the West Shore road to Milford, and two projected parallels of the Derby division of the Consolidated road from Derby to New Haven. In two of these cases the deadly decision was made by the railroad committee that electric companies intending to own their roadbed must come in under the general steam railroad statute passed 20 years ago, and expressly intended by the Consolidated Company to impede steam parallel schemes. Its provisions are very severe, compelling, for example, large subscriptions per mile and prepayments before construction can be begun ; and all the costly obstructions to a steam enterprise were thus made, by the committee's ruling, to apply to an electric road. The decision is absolutely technical, turning upon the point that the general electric law refers in terms to "street" railways ; hence, as an electric company owning its roadbed is not a street railroad, it falls under the general steam-railroad law. While the committee's ruling follows the strict letter of the statute, it breaks its spirit, and its undue severity is manifest. Under it an electric company in Connecticut must confront the popular feeling against occupancy of rural highways on the one hand, and, on the other, the impeding clauses of the general steam railroad law. In consequence, during the last few weeks of the legislative session, projectors of many trolley lines have had to be suppliants at the feet of the steam companies.

The many and long hearings in committee on the trolley schemes, while abounding in rhetoric and repartee, have contributed but little to the sober analysis of the subject. Counsel for the steam companies have appealed for protection of them as "children of Connecticut," as trustees of conservative and old vested interests, as large taxpayers, and as purveyors of safe, quick, and cheap service; while their opponents have urged with more force than effect the benefits and rights of new invention. This branch of the subject may be dismissed as falling into the limbo of commercial partisanship, save a reference to the claim of the steam companies that the trolley, being but "steam power applied at a distance," falls under the same rule of law as the more direct application of steam in the locomotive.

Intelligent public opinion in Connecticut, as distinguished from partisan opinion on the one hand and mere ignorance on the other, has passed through two stages, and is now in a third. At first it was distinctly hostile to the trolley during the period when electric transit was in its first ventures, when its equipment was bad, and when the noisy roads were deemed by many a crying nuisance. Later, as the system developed, public sentiment in both city and country became much more hospitable, and it was during this epoch that many streets and highways were rashly surrendered and valuable franchises granted without returns and with very inadequate restrictions or none. Since then there has been another reaction against the trolley, but along more rational and moderate lines. Popular judgment evidently favors now higher taxation of the trolley companies, the jealous preservation of the country highways both for present needs and future improvement, making the trolley companies pay for occupancy of city streets, and sharp checks on speculative financiering of trolley schemes. On the other hand, the plea of the steam companies that as vested interests they are entitled *ipso facto* to a cover against new invention on new application of old motive force finds scant favor, the recognized limitation here being that, where money seeks investment in a *bona fide* trolley enterprise, the test is a fair one of public necessity, whatever the steam companies may allege. As against the old vested funds, the rule holds clearly that electricity, paying fairly for its privileges, excluded from the public highways in rural districts and buying its own right of way, has a right to work out its own future, whether as a "parallel" or not. In that direction, at least, public opinion in Connecticut now strongly tends, and later is likely to crystallize, though perhaps not before steam and the trolley have brought many new and bitter conflicts.

UNINHABITABLE HOUSES IN CITY SLUMS.*

By William Stevenson.

THIS subject of unhealthy houses has been recently discussed by two very eminent and learned gentlemen, each on different occasions and in different towns. At the Sanitary Congress held in Glasgow, Dr. Russell, medical officer of health for Glasgow, read a paper on "Uninhabitable Houses: who inhabit them? who own them? and what is to be done with them?" In that paper Dr. Russell laid the blame for unhealthy houses on the immoral compact entered into between the tenant and the landlord, declaring that this compact was leading landlords, factors, trustees, beneficiaries, bondholders, and tenants down the broad road to perdition. On a more recent occasion, at Birmingham, this same question was made part of the groundwork and foundation of a great political speech by Mr. Chamberlain. He implied that houses became unhealthy because every man was not his own landlord. His words were: "I want to deal with the individual home. What is the best security and guarantee that the home of the workingman shall be comfortable and shall be healthy? It is that a man shall be the owner of his own dwelling."

I have read the statements of both of these gentlemen as they appeared in the newspapers, but I have failed to find that either of them has studied the question to its foundation or traced the disease to the first cause, and thus neither has been able to put forward a satisfactory specific for remedying the evil complained of.

Every man his own landlord and the owner of his own home is not a new cry and watchword, but a very old one indeed, dating back for the last 45 years to my own personal knowledge. It is an old story, and one which has been fostered and nursed by all kinds of building associations, loan societies, and companies of a kindred kind. Edinburgh and Leith, where these societies have been sown broadcast, are peculiarly applicable as evidence of the success or non-success of the proposal "that the best security and guarantee that the home of the workingman shall be comfortable, and shall be healthy, is that every man shall be owner of his own dwelling." I question if any two towns can be found in the kingdom where, from the house of the ordinary workingman and artisan, up through the middle to the more wealthy classes, so large a proportion of houses is owned, and has been owned and occupied, by their owners. The owning and occupying by their owners of single houses in Edinburgh and Leith is not a thing of yesterday, but of generations back.

---

* A lecture recently delivered by Mr. William Stevenson, house factor, Leith, before the Unionist Club, London.

Within the last 20 or 30 years whole streets of new houses have been built in new and in suburban localities, suitable for occupation by the artisan, and by others higher in the social scale, and have been sold, to be so owned and so occupied by their owners. Houses of a less pretentious and imposing kind than the ordinary tenement have also been put up by building companies and by other builders, and with plots of ground, and have been disposed of to be occupied by their owners. The advertising pages of the newspapers afford indisputable evidence of the extent to which individual ownership of single houses prevails. The newspaper columns are filled with flats, half-flats, and single houses for sale; but full and complete tenements, put into the market, are comparatively few indeed. It may be true—at least it cannot be gainsaid—that all these houses, when first built, were considered of the most perfect construction, and were supplied with the most modern sanitary appliances of the times. But do we find on inquiry and investigation that all these houses, which were bought by their owners for their own homes, are still in a healthy, sanitary, and comfortable state, according to present-day requirements? Are one-fourth of the houses built within the last fifteen or twenty years now in such a condition of repair and of sanitary convenience as will fully meet the requirements of tenants, and stand modern scientific tests and requirements? If I am right in my conclusions and in the statements which I put before you, then the proposition "that every man, the owner of his own home, makes healthy and comfortable houses" is a fallacy and a delusion, and will not bear investigation. This fact leads me to consider and inquire how it comes about that the houses which have been built, even at a very recent date, and which, when built, were constructed on the most approved plan and fitted with sanitary appliances and other modern conveniences of the then most perfect kind, should in a very few short years become, so to speak, unhealthy. In house property we have a commodity of human construction, capable of almost indefinite increase, but a commodity subject, immediately on completion, to decay and deterioration, and from the very first requiring constant care and attention to keep it in repair and order. If we exclude premises owned and held for manufacturing and mercantile purposes, and confine our inquiries specially to house property, I think it will be found that comparatively little is held in ownership by the upper or wealthy classes, but that it is held by the lower or less wealthy classes, not for speculation, but as a sure and safe investment, and held by persons who have acquired the means they are possessed of by care and frugality, and who have invested the whole, or nearly so, of their means in property as a competency for old age for themselves and wives, and with the expected reversion to their families or relatives after their death. In the investing of their carefully-gathered means little account has been taken of, and no provision has been made for, the continual outlay required for the repairs and upkeep which is necessary on house property. If money has been borrowed on bond or mortgage, as is often the case, the strain on the resources of the holding to make all ends meet is excessive. Every penny possible requires to be exacted from the rents by the owner or the life-renter. Not more than what is absolutely compulsory is expended either on repairs or improvements. The better class of tenants gradually remove to houses of more recent construction, and where they find the more modern appliances and conveniences. The houses have to be let to a class of more undesirable tenants, and gradually the property gets into disrepair, and from bad to worse goes down the hill, till ultimately, when it reaches the beneficiary, it is scarcely worth having.

In the case of tenements or other blocks of building owned by a separate individual for every separate house, and having many rights in common, repairs cannot be easily executed, except under compulsion of the authorities, and then only of the barest needs, and at a cost out of all proportion to the amount of work done. All this, perhaps, from the want of means by some, or want of inclination by others, of the common owners. If one owner desires improvement of his holding or the introduction of some more modern convenience or sanitary appliance, he is handicapped in his attempt to effect it, except at an inconvenience and cost disproportionate to the value of the alteration wanted. There is little or no control over the introduction of undesirable neighbors, and by the introduction of such persons the neighborhood becomes deteriorated. The dissatisfied leave the place, and either sell their house at a loss or let it at what rent can be got and to such tenants as they can command. And so this neighborhood also gradually goes down the hill and becomes an undesirable locality. Owners of single houses and property in common are handicapped at every corner against keeping their holdings in a good and healthy condition and repair by the disregard, carelessness, or impecuniosity of their neighboring owners. Many owners of their own houses, who are sensible of the insanitary and uncomfortable condition of their dwellings, continue from year to year to occupy them, well knowing and hiding their defects because of inability to meet the outlay, or perhaps a want of desire to effect the improvement; and it is only after the property is put into the market that the defects are found out.

In all large trading or manufacturing concerns managed on true business principles a certain portion of the profits are yearly set aside to meet depreciation, and for repairs and renewals. This is specially the case with our most successful shipping companies. I have never yet found any such thing as a reserve fund of this kind with individual owners of house property. Herein lies a pertinent cause of uninhabitable and insanitary dwellings. I have pointed out how liable house property is to decay and to deterioration. But hitherto it has been held as if it were an investment practically incapable of decay or deterioration, and as if, after having been once built, it were incapable of improvement, and had no necessity for any reserve funds for effecting these objects,—in short, held on rule of thumb, and on no business or commercial principle whatever, no provision or calculation being made for decay. Building and other loan societies, and the easy facilities with which loans can be got on mortgage over house property, are much to blame for bringing into the field of ownership large numbers of impecunious persons, who have not the wherewithal to hold on business and commercial principles the property they have acquired, and to maintain it in that state of repair and health which is required, even when they have the desire and knowledge to do so. Many persons become owners of their own houses and of property, who have never counted the cost on any sound business system.

There are most certainly—and it would be a pity if it were not so—very many individual owners of house property who hold their property as an investment, and who, during their own lifetime and with their own sanction, have the greatest care and concern that their properties should be always kept in the highest and most perfect state of substantial repair. But the life of every person is an uncertain commodity, and, when that passes away, then come other rules and other modes of management.

The leaving of property in life-rent has hitherto been a fruitful cause of rapidly leading property to decay and ruin. A life-renter has no interest in many cases in maintaining the property in any better repair than is sufficient to take as much out of the holding as possible. Needful repairs are executed with a grudge. Any substantial improvement which would retain a good class of tenants is absolutely refused. One by one the good tenants remove, and their place is bit by bit refilled by a lower and still lower class of tenants. The property itself not only goes to decay, but the neighborhood and neighboring properties become deteriorated past recovery at the same time.

The carelessness and indifference of tenants, and not infrequently wilful destruction by them of property, is becoming more and more every year a burning question, and one which will in the near future have to be sternly faced. The destruction from carelessness and indifference is not confined to the lower class of tenants, but is a cause of complaint against many of the would-be upper class, and whose standing and position lead to an expectation of better things.

Neighboring owners, I have said, and as I have good reason to know, are often the cause of the deterioration of a neighborhood. Thoughtless and regardless modes of management lead to serious loss to other owners who have the best intentions.

Trustees holding for beneficiaries and heritable creditors in possession have hitherto been seriously handicapped in keeping and maintaining property in a good and lettable condition, and abreast of modern improved requirements. They had power only to do necessary repairs. When mortgages had been foreclosed, it was a certainty that the free income from property had been insufficient to meet the interest. In such cases it was almost hopeless to expect improvements or any repairs beyond those allowed by law. The buildings may have been good and substantial so far, but by the inability of the holders to introduce from time to time better and more modern conveniences it is found impossible to retain the best class of tenants. They migrate to where these modern conveniences are found. The heritable securities act, just become law, will substantially improve the position of heritable creditors in possession.

The jerry-builder is the back on which is most often laid the blame for unhealthy and insanitary houses. The speculative builder is not an article of self-creation. He was brought into existence to meet the demand for a cheap and flimsy article. He is not to be blamed for providing the article wanted by impecunious buyers, greedy of big interest and big bargains, and who have neither the knowledge or the desire to appreciate a good and substantial article,—the best value in the end. He is the counterpart of the Cheap Jack, and owners of the slop-shops on the bridges and elsewhere, who supply the demands for the cheapest clothing and other articles. Even Mr. Chamberlain in his speech at Birmingham stated that he had been in search of a Cheap Jack, and had found one who could supply the very best article in the market in the way of healthy houses for workingmen at £140 each.

In the preceding remarks, if you will allow me shortly to recapitulate, I have pointed out that the owning of their own homes by the occupiers has not been successful in making healthy and comfortable houses, but, on the contrary, has specially contributed in Edinburgh and Leith in making houses unhealthy and insanitary. I have pointed out that the system of leaving property on life-rent is another of the causes which contributes to the same end. I have shown that the holding of property by bondholders and by trustees assisted to the same end. I have also shown that even the individual owner of property having the best intentions, and because of neighboring owners and the uncertainty of his own existence, and because of the inability to control what may come after him, is unable to prevent the very best class of property from becoming unhealthy, and I pointed out that a serious factor in the question is the universal want of any reserve fund on which to rely for effecting repairs and renewals. These and the want of a perpetual and continuous system of management, continuing from year to year in perpetuity and without a break, all lead to the same end. Experience has thus taught us in the past, and the reports of medical officers of health and sanitary inspectors tell us in the present, that individual ownership of house property has been unable and unsuccessful in its management in preventing property from becoming the slums and the rookeries of our towns.

I now come to the second part of my story, and the more pertinent point,—the remedy which I would apply. If my indictment against the holding of property privately or by individual owners is found to be relevant, and if the proof which I have set before you brings in a true bill, as I hold it does, then I submit that all individual and private ownership in house property in towns should cease and terminate. I make the recommendation advisedly, unreservedly, and in its broadest sense to all house property having common rights. In the owning of property for letting purposes I would exclude the State ; I would exclude municipal authorities and every other elected body elected by the ratepayers for administrative purposes only. The constitution of all such bodies unfits them for the management of commercial and mercantile undertakings.

I would like to see, and I recommend, that the owning of house property be taken up by joint-stock companies, or such like corporations, or by some kind of syndicate, and which might be limited and might be coöperative. In the formation of such companies and corporations there could be no risk if judiciously gone about. The property would be managed from year to year on uniform and business principles, and with perpetual succession in the management,—uniform and continuous ; not erratic, spasmodic, and uncertain. The dividends would be paid half-year and half-year, uniform and of known quantity, with sufficient reserve for all emergencies or improvements and for renewals. I see no reason why workingmen of all classes should not join in and invest their frugal savings in such a manner from the single £1 and upwards. Such investments would not be speculative,—expected to yield from 6 to 10 per cent.,—but I see no reason why a uniform and constant dividend of 4 to 4½ per cent. should not be made. In such companies owning whole and undivided blocks of houses, and having no mutual obligations, improvements in internal arrangements and fittings, and the introduction from time to time of the most modern and approved sanitary appliances, could be effected with perfect facility and freedom, as it was found that such became necessary and advantageous for maintaining the houses in the best and most forward condition ; by always keeping the houses in such forward condition, retaining and keeping the best class of tenants, the locality also would be maintained in a high-class position. In such companies or corporations shareholders and members could with every confidence bequeath the life rent to one person and the fee in reversion to others, knowing that the life-renter would have no control in deteriorating the principal, and that the fee would go down to the reversionaries unimpaired, and in the same substantial condition in which it was left at the date of bequest.

The model after which I suggest construction is the insurance companies and the Scottish bank. Intelligent and energetic artisans would be of the utmost use in the management. Their training in various trades connected with property would make them so. And if we are to believe in the success of the coöperative enterprise and benefit societies, it is manifest that they have business capacity.

I have been unable to find out the existence of any kind of company or association in Scotland of the nature or constitution I recommend, except one in Glasgow,—The Glasgow Workman's Dwellings Company, Limited. It has been in existence for a short time only, and on June 30 last they issued their first full year's statement of accounts. Through the courtesy of their secretary I have been furnished with a copy of that report and with other documents relating to the company. The paid-up capital is nearly £15,000. After paying all expenses for the year,—one-third of the preliminary expenses in forming the company,—a dividend of 3½ per cent. was paid. £198 was placed to a reserve fund, and £36 was carried forward to next year. The company's operations consist chiefly in buying up old and insanitary property, and, after putting it into a perfect state, letting it out. The rents are all weekly, and from 2*s.* to 3*s.* This company is perhaps of a semi-charitable nature, but it is substantial proof of what can be done with even the lowest class of property, and with the poorest but decent laboring classes. It is providing them with good and healthy houses, and it is paying the shareholders of the company an honest dividend.

IMPROVEMENT OF THE DELAWARE RIVER AND THE HARBOR OF PHILADELPHIA.

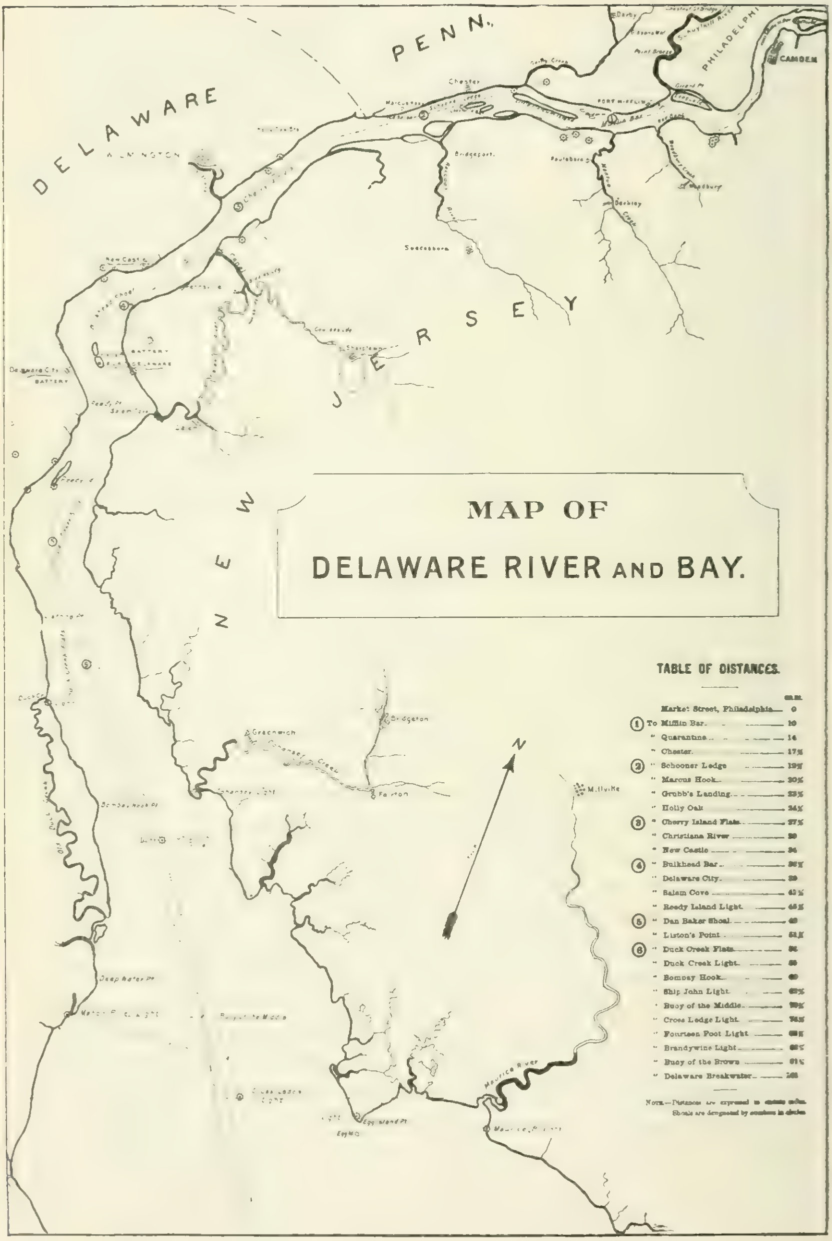
By John Birkinbine.

THERE is now in progress an improvement of the Delaware river believed to be the most pretentious attempt yet made to regulate a tidal stream and maintain the channel mainly by tidal influences; and the work of rectifying the harbor of Philadelphia has caused the assemblage of a fleet of dredges which has probably never been exceeded in capacity.

The portion of the Delaware river affected by tides embraces a distance of 135 statute miles from Trenton, N. J., the head of navigation, to the Delaware breakwater at Cape Henlopen, its eastern shore being in New Jersey, while of the western shore 63 miles are in Pennsylvania and 72 miles in Delaware, half of the latter bounding Delaware bay (see map 1).

From the Delaware breakwater at Cape Henlopen to the commercial portion of Philadelphia—a distance of 100 miles—vessels drawing 20 ft. now pass at any stage of the tide, which has a rise of 4 ft. 5 in. at the Capes, 6 ft. at Philadelphia, and 4 ft. 1 in. at Trenton. The removal of six shoals which obstruct 16 miles of the river channel at the points indicated on map 1, and the widening of the channel, will give a draft of 26 ft. at low tide in a channel remarkably direct and 600 ft. wide, as a minimum, between the ocean and Philadelphia.

Up to about 1870 the river channel over the different shoals below Philadelphia had considerably less water than now, for the draft has been increased by dredging and by dykes, so as to admit of the passage of large vessels at high water. The augmented size and draft of vessels, however, make imperative the further improvement of the river, so that the port of Philadelphia shall be no less accessible to foreign trade than the ports of New York, Boston, and Baltimore. But the biannual appropriations as made available by the general government would postpone the completion of the work too long, and Philadelphia has supplemented the government allowance for improving the Delaware river below the city. Similar assistance has already been given by the municipality and commonwealth for the improvement of the harbor of Philadelphia; for, as the Delaware river is well lighted and buoyed, the commercial advantages which would follow improved facilities for water transportation would only be obtained by perfecting the harbor of Philadelphia, so as to invite the largest shipping to use it



MAP OF

DELAWARE RIVER AND BAY.

TABLE OF DISTANCES.

		st.m.
	Market Street, Philadelphia	0
①	To Mifflin Bar	10
	" Quarantine	14
	" Chester	17½
②	" Schooner Ledge	19½
	" Marcus Hook	20½
	" Grubb's Landing	23½
	" Holly Oak	24½
③	" Cherry Island Flats	27½
	" Christiana River	30
	" New Castle	34
④	" Bulkhead Bar	36½
	" Delaware City	39
	" Salem Cove	43½
	" Reedy Island Light	45½
⑤	" Dan Baker Shoal	49
	" Liston's Point	51½
⑥	" Duck Creek Flats	54
	" Duck Creek Light	58
	" Bombay Hook	60
	" Ship John Light	63½
	" Buoy of the Middle	70½
	" Cross Ledge Light	74½
	" Fourteen Foot Light	80½
	" Brandywine Light	88½
	" Buoy of the Brown	91½
	" Delaware Breakwater	103

NOTE.—Distances are expressed in statute miles.
Shoals are designated by numbers in circles.

liberally. The amount of money represented in a modern vessel is too great to permit of the delays involved in waiting for favorable conditions of tide in order to pass shoals.

From Trenton to near Bordentown, N. J. (5 miles), the river is from 800 to 2000 ft. wide, the channel being available for small craft only. From Bordentown (where the Delaware and Raritan canal connects the Delaware river with the harbor of New York) to the upper boundary of Philadelphia (18 miles) the river varies from 800 to 3400 ft. in width.

Opposite Philadelphia is Camden, N. J., and between these two cities there were three islands, which were considered as seriously influencing the tidal currents, the river being broadened at one point to 6000 ft. The rectification of the harbor of Philadelphia required the entire removal of two islands, the partial removal of the third opposite large coal shipping docks and Cramps' ship-building works, and the advance of the pier-head lines along the river fronts of both Philadelphia and Camden.

South of the sites of these islands the river broadens, and 6 miles below, on League Island at the mouth of the Schuylkill river, but within the limits of Philadelphia, is the United States navy yard.

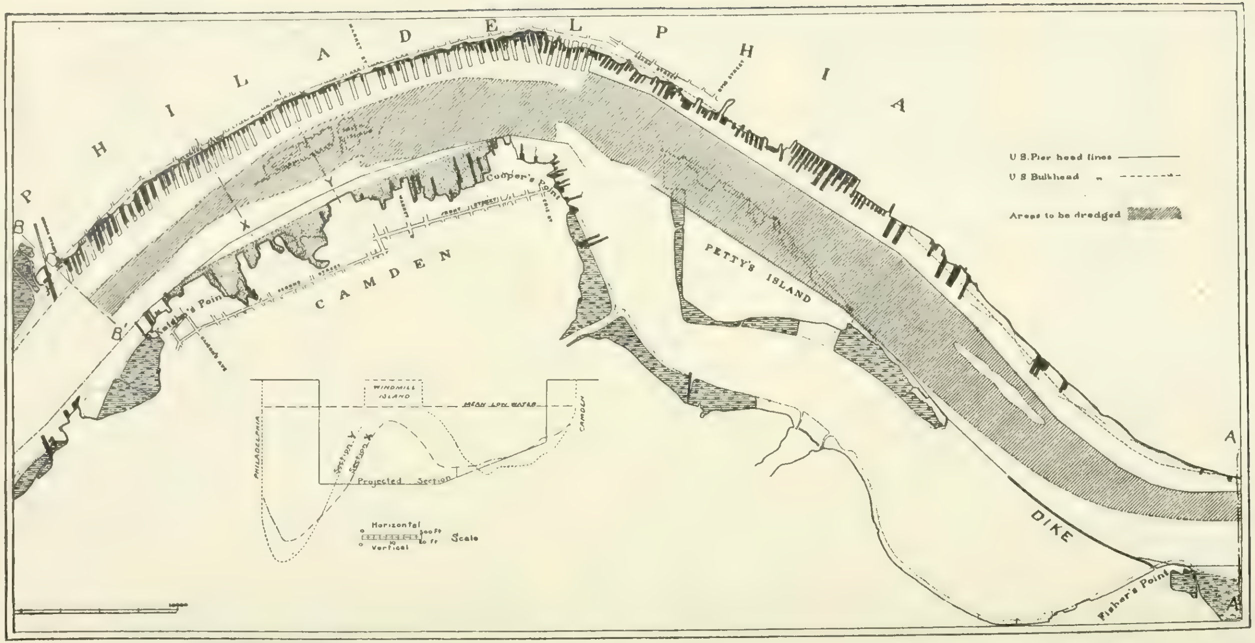
Continuing below Philadelphia, the river proper, constantly widening, extends to Delaware bay, which has a maximum width of 27 miles, but is contracted at its entrance to 11½ miles between Capes May and Henlopen. The gradual widening of the river as it approaches the sea is advantageous for the admission and to promote the regular flow of the tides, the retardation of the tidal waves being such that, when it is high water at the breakwater (where Delaware bay debouches into the ocean), it is low water at the northern boundary of Philadelphia. The descent of the river bottom from Philadelphia to the sea is between 2 and 3 ft.; therefore, when the tide is commencing to ebb at Philadelphia, a vessel entering the capes is floating on water several feet higher than the water at Philadelphia, and, if this vessel travelled at the rate of from 16 to 19 miles per hour, it would come all the way up to the city with the tide at flood level. The flood tide lasts about 5, and the ebb tide 7½, hours at Philadelphia.

Major C. W. Raymond of the Engineer Corps, U. S. A., in charge of the work on the Delaware river, asserts that wave action as affecting the channel ceases 50 miles from the ocean, and he considers that between Philadelphia and the limit of wave action the channel is acted upon by the tidal forces only, this portion of the river being designated "The estuary of the Delaware."

According to Mr. L. Y. Schermerhorn,* gagings indicate that

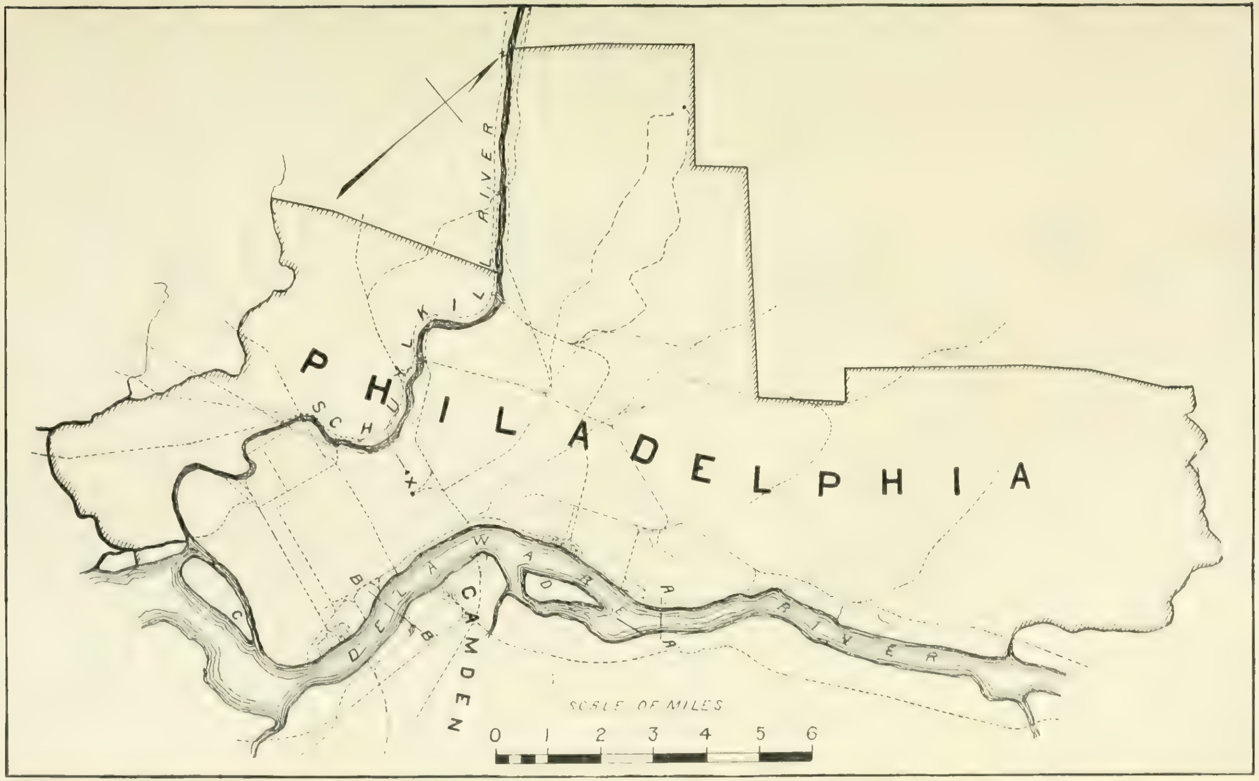
---

* Proceedings of the Engineers' Club of Philadelphia, Vol. XI.



DANDO PRINT, PHILADELPHIA

SKETCH OF THE PORTION OF PHILADELPHIA HARBOR UNDER CONTRACT FOR RECTIFICATION.



MAP OF THE CITY OF PHILADELPHIA, PA., SHOWING THE RIVERS AND THE RAILROAD CONNECTIONS.

2,000,000,000 cu. ft. of water pass through the harbor of Philadelphia with each ebb tide, and 1,860,000,000 cu. ft. with each flood tide,—a volume of 245,000,000 tons of water passing daily. Gagings of the river above tidal influences in months free from freshets indicate a flow of 3300 cu. ft. per second, or 285,000,000 cu. ft. per day.

This river has the peculiarity of showing close correspondence to an empirical formula for retardation as determined by the United States Coast Survey,—*viz.*,

$$\text{Flood,}\quad y = 2.2\ x + 0.018\ x^2$$

$$\text{Ebb,}\quad y^1 = 3.4\ x + 0.018\ x^2$$

in which y and y^1 are the retardation in minutes and x is the distance from the breakwater in nautical miles.

The improvement of the Delaware river may be considered under two general heads,—*viz.*, the estuary, and Philadelphia harbor.

Map 1 shows the general course and shore of the estuary of the Delaware from the upper portion of Philadelphia to the Atlantic ocean, the prominent towns and the location of existing channel obstructions also being indicated.

In the scheme for the improvement of the Delaware river devised by a board of the Engineers' Corps of the United States Army in 1885, a ship canal, having a least width of 600 ft. and a depth of 26 ft. at mean low water from Philadelphia to deep water in Delaware bay, is to be obtained by regulating the tidal flow by dikes, with recourse to dredging, where necessary, and as an aid to such contracting and regulating works. Major Raymond* says that the river above the estuary receives a considerable amount of material from above tide water, and deposits the greater—that is, the heavier—portion of it between the head of the tide and the lowest point to which one ebb current reaches. Below this reach, material held in suspension, whether from above tide water or scoured from the bed and banks, is carried down stream by each recurring ebb, until it reaches a point where the conditions are favorable for its deposit. The flood and ebb currents, following different paths, often run on opposite sides of the river, the space between them being a region of weak currents, where the conditions are favorable for the building up of a shoal; also, where the river runs in a wide natural depression in which it did not fully form its own bed, the water will spread out, and its velocity will be diminished, and material will be deposited until the cross section is reduced to its normal dimensions,—*i. e.*, the dimensions maintained by the tidal forces only. But in such material as compasses the bed of the Delaware river it is possible to maintain a channel of greater depth than the unaided power of the river is able to create. As part of the channel between high and low water is exposed to the action of ice and storms and the encroachment of animals and man, the average width of the river is greater than the normal width, and the average depth less than the normal depth. The project submitted by the board of engineers in 1885 was simply to deepen and maintain the channel at six points of obstruction by building stone dikes from 5000 to 25,000 ft. in length, at or below the level of low water, generally on the west side of the channel. If these works did not produce the desired effects, dikes opposite them on the eastern bank of the river were to be constructed. Subsequent investigation indicated that in the Delaware river the dikes should be extended above high water, and this policy is now being carried out.

---

* A lecture delivered at the United States Engineering School at Willet's Point.

The position taken is that dikes improve a channel either by training the tidal currents so that they work together, and in the proper places, or they increase the intensity of the tidal action by confining the flow within narrower limits than those which it previously occupied, or in both these ways together.

In rivers where fresh water forms a large part of the volume passing through the channel, as is the case in most European rivers which have been improved, it may be desirable to place the dikes within the limits of the normal tidal width ; and, when this is done to increase the effect of the fresh water, the dikes must be kept at or below low water, in order to reduce the normal dimensions of the tidal prism. In a purely tidal river like the Delaware (that is, in one where the fresh-water discharge is so small—about 9 per cent.—that it may be neglected in comparison with the tidal volume) it is doubtful whether much permanent improvement can be obtained by low-water dikes.

The single dikes on the Delaware river, constructed in accordance with the adopted plan, have, as far as completed, indicated an ability to maintain, and in some instances to create and maintain, the channel depths ; and the increase in height which has carried most of these dikes 2 ft. above high tide has apparently borne out the above conclusions.

The removal of the six shoals in the Delaware river, while of technical interest and commercial importance, is less of a problem, financially considered, than the dredging of the bar of the Mersey river, which handicapped the trade of Liverpool ; and the cost of such removal will be but small when compared to the expenditures upon schemes of canalization which have been carried out to improve the facilities of Glasgow, Scotland, or Manchester, England.

The improvement of the portion of the Delaware river considered as the harbor of Philadelphia requires special treatment, including dredging liberal amounts of material, removing islands and bars, and adapting the average cross section to what is considered as the normal area.

Map 3 shows the position of Philadelphia with its river frontage and its railroad facilities. The portion of the harbor now under contract for improvement is shaded, and embraced between the lines A A^1 and B B^1, the business center of the city being indicated by the mark X, which represents the location of the municipal building and the two great railroad passenger terminals. Areas which are being filled with a portion of the dredged material are shown at C and D. Congress has lately authorized the construction of a railroad drawbridge just above the northern terminus of the dredging now in progress; this bridge, upon which work is now being prosecuted, is near the line A-A^1. Objection to its construction is made on account of the bridge floor being but 50 ft. above high water. The water-front of Philadelphia extends 20 miles along the Delaware, 6 miles of which are covered by the improvement now under contract; and, in addition to the Delaware river frontage, there is the tidal portion of the Schuylkill river, which is navigable for vessels drawing 18 to 23 ft. for 7.3 miles,—wharves, manufacturing industries, grain elevators, oil-refining works, etc., lining both sides of the stream.

The work of rectifying the harbor of Philadelphia, as set forth in the specifications, contemplates the formation of a channel about 2000 ft. in width, with a cross section of 55,000 sq. ft. at mean tide for 6 miles along the Philadelphia shore (between points A and B), at a distance far enough from the present wharf-line to permit the extension of the wharves 500 to 600 ft., and the widening of the avenue at their shore ends; the removal of Windmill and Smith islands and the adjacent shoals, so as to form a 26-ft. channel about 1000 ft. wide along the front of the revised Philadelphia wharf-line; widening the Pennsylvania channel at Petty island to about 2000 ft. with a depth of 26 ft. over a width of about 1000 ft., the channel sloping to a depth of 12 ft. in the remaining width, and a resulting cross section of about 55,000 sq. ft. (see sections on map 2).

Smith and Windmill islands were situated about 800 ft. from the ends of the existing Philadelphia wharves, and about 1200 ft. from the ends of the Camden wharves. The area of Smith island—about 8 acres—was partly inclosed by a revetment of cribwork, piling, and wharves, generally backed with stones; and just north of it there was a cross channel revetted on both sides by pile dikes, filled with stone and gravel. Above it was a shoal extending about 1 mile toward Petty island, and having on it less than 6 ft. at mean low water.

The area of Windmill island was originally about 17 acres; a portion of it was revetted with crib-work, piling, and wharves backed with stones. Below the island was a shoal, having on it an average depth of about 10 2-10 ft. at mean low water for a distance of about ¾ of a mile.

The surface of the islands averaged about 9 ft. above mean low water, and about 3 ft. above mean high water. From borings made in the Delaware river, it appears that rock was not encountered at a depth of less than 39 ft., and on the bar just above Smith island it was reached only at a depth of over 100 ft., and on the islands no rock was reached at a depth of 24 ft. below mean low water.

Petty island, situated 2 miles above the head of Smith island (the two being almost connected by shoals), was about 2 miles long, and had an area of about 360 acres. Its surface, being chiefly below the plane of high water, is protected from overflow by earthen dikes. The plan of improvement contemplates the removal of a part of the northern side of the island, some of the dredged material being employed to raise the surface of the remaining portion. The shore line is partially protected by wharves and timber revetment.

The work required the removal of all trees, structures, pile and timber wharfing or revetment from the islands, and the timber work of the dikes which form the cross channel ; also the removal by dredging and by natural scour of the tidal currents of 21,500,000 cu. yds. of material, place measurement.

A part of the dredged material is deposited and spread on League island (at C, map 2) by hydraulic conveyors. It was estimated that 2,000,000 cu. yds., place measurement, would be required for filling the spaces designated ; but the government reserved the right to require an additional amount of dredged material not exceeding 5,500,000 cu. yds., place measurement, to be deposited and spread within the limits of League island navy yard in locations to be indicated ; all dredged material not otherwise provided for to be deposited behind the Mifflin bar dike, about 10 miles below Windmill island, and in the back channel of League island navy yard.

Dredging is paid for by the cubic yard as measured in scows, except when the material is placed on Petty island, in which case it is paid for by the cubic yard as measured in the dipper. All measurements are made at the place of deposit. The deposit and spreading at League island is paid for by the cubic yard as measured in place in the fill above the present surface of the ground, with no allowance for shrinkage or settlement.

Map 3 shows in detail the portion of the Delaware river now being improved, the shaded portion exhibiting the area to be dredged ; it will be noted that this area covers Smith and Windmill islands, which have been entirely removed, and a part of Petty island, which is being cut away. Original cross sections of the river at two points and the projected section as it will appear when the work is completed are also indicated. The present wharves are shown in full, and their extension in outline for a portion of the Philadelphia water-front.

The narrowing of the channel is secured by a material advance of the pier head lines on both Philadelphia and Camden water-fronts, to secure a cross section approximating what is estimated by the United States Engineer Corps to be the normal channel section.

The record of the improvement of Philadelphia harbor properly commences in 1888 with a resolution of congress providing for a commission of three engineers to examine and report in relation to the Delaware river between Philadelphia and Camden, and authorized to establish harbor lines. The board now consists of Col. Craighill, Lieut. Col. Comstock, and Maj. Raymond, the latter the engineer in charge. In April, 1891, a contract was entered into; but before the close of 1892 this contract was annulled, because of "failure to prosecute the work faithfully and diligently." After readvertising, a contract was entered into on June 1, 1892, with the American Dredging Company, at the following prices: 14.2 cents per cubic yard for excavating and depositing material at places approved by the engineer in charge; $1.90 per linear foot for removing pile and timber wharfing or revetment; and 16 cents per cubic yard additional for depositing and spreading material upon League island. The requirements were that 900,000 cu. yds. were to be removed during the first 3 months (July, August, and September, 1893), 350,000 cu. yds. being dredged each succeeding month, and that a total of 3,000,000 cu. yds. were to be removed by June 30, 1894, and 5,100,000 cu. yds. by December 31, 1894.

Work was properly commenced, and a fleet of tugs, dredges, and scows assembled. Up to the close of the fiscal year ending June 30, 1894, the record, according to the report of the chief of engineers, was as follows: Smith and Windmill islands were entirely removed to a level of not less than 12 ft. below mean low-water, and the northern side of Petty island was dredged back so as to give a minimum width of about 1400 ft. to the Pennsylvania channel. The total amount of work accomplished to June 30, 1894, was: material removed by dredging, scow measurement, 5,842,927 cu. yds.; piling and revetment removed, 22,664 linear ft.; dredged material deposited and spread on League island, scow measurement, 1,636,087 cu. yds. These amounts were in excess of the requirements of the specifications, but work was continued energetically until December 29, 1894, although the appropriation available had been exhausted; and, when operation was suspended for the winter, the record showed: dredged material removed by scows, 7,675,230 cu. yds.; dredged material deposited upon Petty island, 739,553 cu. yds.; total, 8,414,783 cu. yds., removed in 20 months,—an excess under the present contract of 62 per cent. In addition 1,740,000 cu. yds. of this material was re-handled and deposited on League island, giving a place measurement of 1,139,000 cu. yds. An interesting feature of the work of the dredges is the apparent increase in volume of scow measurement over the quantity *in situ*, and the shrinkage and loss when redeposited. One thousand cu. yds. in place in the bed of the river measured in scows about 1250 cu. yds.; but, after the scows have been dumped, and the material sucked up by the pumps and carried onto League island, this original 1000 cu. yds. measures in place but 780 cu. yds.

The volume of water used to convey mud and gravel is eight to nine times that of the material carried, and the greatest distance to which this has been conveyed in the 30-in. conduit pipes connecting with League island is about ½ mile.

On both sides of the Delaware river there is land below high-water level which is protected by dikes, upon which the excellent filling material being dredged could be placed with advantage; but, owing to the failure of property-owners to recognize the present advantage, great quantities are being dumped in unused or shallow portions of the stream.

If to the quantity dredged up to December, 1894, is added the amount re-handled in filling League island, the total will be in excess of 10,000,000 cu. yds., scow measurement,—a quantity which would cover an area of 1 square mile about 10 ft. deep. This has been moved by an equipment of from 10 to 14 dipper and grapple dredges, three hydraulic dredges, 75 to 90 dump scows, holding an aggregate of 25,000 to 30,000 cu. yds., and 18 to 25 steam tugs; which, if placed in line, would make a procession 2½ miles long, representing an outlay of $1,250,000. The force of men required to operate and care for the equipment of dredges, tugs, and scows ranges from 300 to 400, in addition to about 100 more engaged in the shops and yards on construction and repair work. From 2000 to 2500 tons of coal are consumed monthly, when the dredges are at work.

In October, 1894, the equipment removed 745,000 cu. yds. by dredging, and deposited 187,000 cu. yds. of this upon League island, —a total for the month of 932,000 cu. yds., or an average of 34,500 cu. yds. handled per working day of 11 hours.

The character of the material excavated varies as widely as its location. In places it consists of nearly clean sand: at others, of soft clay and sand mixed in proportions varying from 25 to 75 per cent.

of either; at other points glacial drift is found composed of hard clay mixed with gravel and large boulders. For the sand, hard clay, gravel, and boulders only dipper dredges can be used with advantage, while in the softer material, consisting of mixed sand and soft clay, the grapple dredges are employed. The capacity of these dredges depends mainly upon the character of material to be excavated, varying from a maximum of 4000 cu. yds. per day in the softer material to 400 cu. yds. per day in the harder.

In disposing of the dredged material the scows are towed distances of from 20 to 35 miles on the round trip, depending upon the location of the dredges in relation to the dumping ground. The towing is done by large tugs hauling fleets of from four to fourteen scows at a time, moving with the tide up and down the river. Usually the tows leave at high water, moving down the stream on the ebb tide, and, after disposing of the contents of the scows, return with the following flood tide.

The estimated cost of the 21,500,000 cu. yds. of dredging required for the rectification of the harbor of Philadelphia is $3,500,000; the cost of removing the shoals below Philadelphia, as before stated, is $2,425,000, of which about $1,000,000 has been paid out; but to complete the harbor facilities Philadelphia will expend probably $8,000,000 in extending wharves to the new dock lines, with slips long and deep enough to accommodate the largest ocean vessels, and in widening Delaware avenue, which skirts the bulkhead line, so as to give ample room for wagon traffic, and also for the railroad tracks by which access will be given to all wharves under equal terms to all railroads entering the city.

When the harbor improvements are completed and the existing obstructions in the Delaware river below the city are removed, Philadelphia should be in position to compete with any other American city on the Atlantic coast for foreign trade, and be able to claim the advantage which its geographical position gives of shorter railroad haul to distributing points for the growing central and western States.

IS THE INVENTIVE FACULTY A MYTH?

By W. H. Smyth.

TO the ordinary mind a profound mystery appears to envelop the work of the inventor. He is looked upon with a species of awe, as one endowed by nature with what is known as the "inventive faculty"; a special organ or sense, having occult capabilities of inspiration and creation; a sort of automatic mental mechanism, needing only that its fortunate possessor should "touch the button" in order that, presto! the desired invention may instantaneously evolve from nothing. In fact, the great mass of even intelligent people of our age regard a noted inventor as nothing less—and nothing more—than a "wizard." As we go on, we shall see that this extraordinary delusion is shared, not only by the majority of inventors themselves, but in effect by the federal courts having jurisdiction in controversies relating to patents for inventions, as well as by the tribunals of the patent office.

The intimate relations which it has been my fortune to sustain with many different inventors through a long period, and my own experience in a capacity which may perhaps be regarded as that of a professional inventor, have led me to adopt certain views as to the nature and qualities of invention, and the mental processes of which the completed invention constitutes the tangible result, which in many respects are widely at variance with those which have heretofore found general acceptance. Whatever may be thought of the correctness of these views, it may at least be affirmed that, when formulated into a working hypothesis, they have enabled inventions to be conceived and worked out with no less certainty and accuracy of results than are common in other departments of science in which the phenomena and processes have been investigated, classified, and subjected to fixed laws. They have further led to the belief that not only is the popular conception of the mental operation of invention a wholly erroneous one, but that what is loosely termed the "faculty of invention" is one which is just as much capable of acquirement by proper instruction and cultivation as any other; in short, that, like carpentry or shoemaking, it is nothing more or less than an art.

If these conclusions be well-founded, it is at once apparent that they tend to bring within the scope of scientific methods one of the most important departments of human endeavor, and one which, even in its present chaotic condition, has perhaps been the most important of all agencies in the advancement of modern civilization.

I hold that that which is commonly termed the "inventive faculty" is nothing more than a combination of certain mental faculties with which every rational human being is endowed to a greater or less extent,—namely, vizualization, memory, and reason.

The mental process involved in making an invention is analogous to that employed by the child in building with his toy blocks. Conceiving the idea of building some sort of house, he first arranges those which he thinks most suitable for the foundation, and continues by selecting from his store of blocks of various shapes and sizes those which he finds best adapted to form the various parts of the complete structure he has in mind. So too the inventor selects from the store of elementary mechanical parts or combinations with which memory has furnished his mind those which he regards as available for his purpose. The child builds and rebuilds; he changes a block here, and removes or adds a block there; so does the inventor, although in his case the mental operations of selection and arrangement are often so quickly and so automatically performed as to escape even his own observation. The material, too, with which the inventor works is infinitely better adapted to its purpose than are the blocks of the child with their unchangeable shapes and dimensions. It may be hard or soft, hot or cold, pervious or impervious, transparent or opaque, elastic or rigid, fluid or viscous: in short, it may be regarded as infinitely plastic, though possessing every other inherent quality known in nature or art.

When confronted with a defect in his structure, the child is compelled to laboriously select from his heap of blocks, critically examining each one and trying its effect as a part of the whole; but the inventor's mass of material is of a much more manageable character. In an instant the panorama of memory is unfolded, and he makes his selection,—a process which may be repeated not merely once, but a hundred times, while the hand of the child would be faltering over a single block. Among this material the mind of the inventor works as a modeller in infinitely plastic clay. With such facilities and such material why should not great results be accomplished? On the contrary, would not he be a bungler indeed who under these conditions should prove to be incapable of producing a worthy result?

Why, then, do we find the patent office at Washington to be a vast storehouse, filled with every conceivable form of foolish, silly, illogical, and useless contrivance? Why this immeasurable waste of money, time, and effort in the production of useless rubbish? Why is it that the very name of "inventor" has become a synonym for an irrational and crack-brained enthusiast, and a title which the originator of an important or valuable device no longer cares to accept? The reason for this state of affairs is not far to seek.

Let us again revert to our illustration of the building-block, and add to the other conditions under which the child is compelled to work one more which is necessary to complete the analogy. Let us assume the blocks to represent, not only the actual things from which the inventor's conceptions have been derived, but his mental conception of those things. A very strange state of affairs now arises, which is due to the difference between the concept and the reality. It is as if, the instant a block were picked up for use, it should, wholly unperceived by the child, assume a distorted shape,—the cube, for example, being no longer cubical, or the cylinder no longer cylindrical. The extent of the distortion, being a variable quantity, may range from an almost immaterial difference to the assumption by the cube and cylinder of the characteristics of each other, to say nothing of infinite possibilities of error in all other directions. Such an imagined distortion of the shape of the blocks is more than paralleled in the distorted mental impressions of exterior objects existing in the mind of the ordinary untrained observer; in fact, it is only the few who observe with even approximate accuracy, and still fewer who have the capacity to retain a correct mental impression of that which they have observed. Let the ordinary person attempt to make a drawing of, say, a round-topped table. After a careful examination, he will probably proceed to draw, to the best of his limited ability, a circle, and next, with more or less accuracy, the legs, ending upon a horizontal line intended to represent the floor. Now mark! the circle has been drawn, not because the impression of a circle has been made upon the retina of the draftsman, and so on his mind, but because he knows, or thinks he knows, that the top is circular. The fact that the legs rest upon the horizontal floor is quite sufficient to justify the delineator in his belief that he sees that which is not to be seen, and he represents it accordingly.

Think of a man, no matter how quick in perception or how logical in mind, but with his memory stocked with erroneous conceptions like these, often not even rising to the dignity of caricatures of the external objects which they are assumed to represent! From such a mass of mental material is it conceivable that it would be possible to produce anything whatever which, when completed, should bear any logical relation to real things? Most certainly not; such a production could only find its fit place among the aggregation of abortive refuse which already encumbers the cabinets of the patent office.

The field of invention extends far beyond the narrow limits which custom has assigned to it; ingenuity and invention may be and are manifested, not alone in the works of the mechanician, but in those of the musician, the poet, the author, the lawyer, the physician, or the theologian. But, alike in the case of these and all other inventors, a certain mental equipment is an indispensable requisite to success. There must exist, first, an unerring and accurate perception of those similarities and differences which are fundamental in their nature ; second, the capacity to distinguish the pertinent from the fortuitous in the particular problem under consideration ; and, third (and this applies particularly to the mechanical inventor), the ability to clearly visualize, so that he may examine his structure as it progresses, and may select and, if need be, adapt, the elements he selects from his store, to the end that they may be coördinated with that structure.

The process of mind which I have termed "visualization" is curiously exemplified in an incident which I will give as nearly as possible in the language of the narrator :

"I have on several occasions surprised myself, so to speak, in the act of going through a mental operation which, for want of a better name, I will call 'manualization,'—that is, using mental hands to manipulate mental material. This has only occurred, so far as I can recall, on occasions when I have been struggling mentally with some aggravatingly refractory problem of mechanical detail, which, though really no more than a pretty little puzzle, has concentrated my attention until the entire mental effort was focused on the rebellious point in strained and intense abstraction, the incomplete portion being in clear and sharp visualization. Then, slowly and as if with great effort, two hands would be laboriously pushed into view, and would take hold of the unfinished part and twist and shape it until it assumed a form adapted to the desired end. Then, like a flash, the strain would relax, the apparition vanish, and I would perceive myself to be a relieved, but exceedingly tired, individual. The visualization, including the hands, would still remain in mental view for possibly a second or two after the completion of the work."

If it were true that the so-called "faculty of invention" is something unique and apart from other forms of mental activity, it would certainly seem as if its manifestations must be so characteristic as to be at once recognizable. Such, however, is by no means the case. Is it not a most suggestive fact that, while the question of the presence or absence of "invention" has constituted the sole and only issue in thousands of contested cases which have been passed upon by the patent office and by the federal courts, not one of these august tribunals has ever succeeded in laying down a definition of that which constitutes invention? Listen to the observations of a learned judge of the supreme court of the United States :

"The truth is, the word [invention] cannot be defined in such a manner as to afford any substantial aid in determining whether a particular device involves an exercise of the inventive faculty or not. . . . . . In a given case we may be able to say that there is present invention of a very high order. In another we can see that there is lacking that *impalpable something* which distinguishes invention from simple mechanical skill."* Is not this condition of mental confusion readily explicable, in view of the suggestion contained in the title of this paper?

Professor Robinson, perhaps the leading authority to-day, at least in the United States, upon questions of this kind, says:

"The mental faculties employed in the inventive act are the creative, not the imitative, faculties. An invention is the product of original thought. It involves spontaneous conception of some idea not previously present to the mind of the inventor. Industry in exploring the discoveries and acquiring the ideas of others, wise judgment in selecting and combining them, mechanical skill in applying them to practical results,—none of these are creation, and none of these enter into the creative act. Only when the mind of the inventor originates an idea new to himself, if not to all the world, does he call into exercise his own inventive skill, and perform the mental portion of the inventive act."†

If the above extract does not embody the popular conception of the nature and attributes of invention referred to in the first paragraph of this paper, I am at a loss to know what meaning is to be attributed to it. I take direct issue with the propositions laid down by Professor Robinson, and contend that the very qualities, faculties, and acts stated by him to be foreign to invention are those which constitute its very essence. It is assumed that something is *created* in the mind of the inventor; that something which had no previous existence is spontaneously generated there. On the contrary, I say that the mind of the inventor is a selective mental apparatus, in which material gathered from the outside is rearranged and adapted to new uses, and that this is nothing different from the normal operation of the human mind in all other operations. If this is not true, and if invention in fact is something other than this, then I can only say that the possibility has been demonstrated that, by the exercise of those faculties of the mind which are "foreign to invention" and those only, results may be produced which are absolutely undistinguishable from "invention of a very high order." If, on the contrary, my contention is well-founded, and there is really no such thing as the so-called "inventive faculty," and if the act which we call invention is nothing more than the normal result of the operation of mental endowments of which all are possessed in a greater or less degree, it must logically follow that, inasmuch as our mental faculties are admitted to be no less capable of cultivation and improvement than our physical faculties, the power of invention or the capacity to invent may be improved and strengthened. It further follows that the operation of these faculties, like other processes, must be capable of being reduced to a definite system, governed by well-defined laws, with manifest advantage in respect to economy of time and effort and certainty of result.

---

* McClain v. Ortmeyer, 141 U. S., 419.

† Robinson on Patents, vol i, sec. i., par. 78.

Despite the unscientific and hap-hazard way in which these important results are attempted to be reached, we boastfully speak of the present time as the "Age of Invention." To me the past and present ages, as respects invention, seem ages of pure empiricism, which bear to the future and real "Age of Invention" much the same relation that the last century bears to the present in respect to theoretical and applied science.

Examine at random any one of half-a-dozen lines of mechanical invention ; one striking characteristic, common to almost all, instantly arrests the attention ; they present nothing more than a mere outgrowth of the manual processes and machines of earlier times. Some operation, once performed wholly by hand-tools, is expedited by some device which enables the foot as well as the hand to be utilized. Then power is applied ; the hand and the foot operation, or perhaps both, are made automatic, and possibly, as a still further improvement, several of these automatic devices are combined into one. The fundamental basis is the old original hand-process, and hence, except in the extremely improbable event that this was the best possible method of accomplishing the result, all the successive improvements are simply in the direction, not of real novelty, but of mere modification and multiplication.

This inevitable tendency of the human mind to follow along well-worn grooves of habit serves to explain the reason of a fact often noticed,—namely, that the most radical and important departures from old methods, by which many of the industries of the world have been completely revolutionized, are nearly always originated by persons wholly ignorant of the accepted practice in the particular industry concerned. There is no conservatism so unyielding as that of the specialist. It is one of the most insidious enemies which the inventor has to encounter ; it is so easy to take things for granted, to let well enough alone. It is this and other considerations of no less significance that I have in mind when I say that the Age of Invention is not yet ; we see only its vague and ill-defined fore-glimmer.

The ideal invention is as positive as a geometrical demonstration ;

hence the actual invention should at least be the logical mechanical complement of the conditions incident to the operation to be performed ; it should be the logical answer to the problem which has been set, and should change only when external conditions change. Therefore an improvement on an invention should be of rare occurrence. The true and complete solution should be reached in the first instance.

I cannot close this line of argument without insisting upon the fact that the first and most important prerequisite to invention is an absolutely clear insight into, and a comprehensive grasp of, all the conditions involved in the problem. My own experience leads me to believe that this prerequisite alone constitutes nine-tenths of the work of invention, and that the remainder, in most cases, practically invents itself, or, to be more accurate, flows therefrom as a logical sequence.

And now, if it be admitted that invention is not an impalpable and indescribable "something," but that, on the contrary, it is the result of wise judgment and trained mechanical skill coöperating to select, combine, and apply observations and conceptions already accumulated, what then?

My answer to this is two-fold, inasmuch as it necessarily implies two radical and far-reaching departures from existing conditions. The first change should consist in eliminating from patent law and patent practice the conceptions which attach to the words "invention" and "invented," and in substituting therefor the ideas embodied in the words "discovery," "discovered," "produced," "thought out," "reasoned out." The mere change of phraseology would in itself go far to put an end to the existing maze of confusion, incident to the determination of the ever-recurring question whether a given device does or does not involve that undefinable, "impalpable something" which the law says is the indispensable requisite to patentability, and would restrict the whole scope of the inquiry to the comparatively simple questions of novelty and utility. The second, and by far the most important, change should consist in the inauguration of a Science of Invention, with all the attributes which that phrase implies. Impressed as I am with the transcendent importance of this branch of the subject, I venture to offer such suggestions as have occurred to me, in the hope that others more competent may be induced to take the matter in hand, and give it the consideration which its importance warrants.

The following should form (in part) the basis of a scheme for the Cultivation of Invention:

1. Accurate and methodical observation.
2. Cultivation of memory, including the faculty of association.

3. Cultivation of clear visualization.

4. Logical reasoning from actual observations.

Particular importance should be attached to accurate observation, inasmuch as this is the indispensable foundation of all real education.

With the above considerations in view, a course of training in which the following exercises are included has suggested itself to me.

First. Drawing from simple objects (not copies) under the following conditions: the object to be carefully examined, then removed, and a drawing made wholly from memory; this to be repeated until the last effort depicts the object as correctly as if drawn directly from it; each successive drawing to be on a separate sheet and removed from view while the succeeding one is in progress; when considerable proficiency has been attained, more complex objects to be substituted, and the time interval increased; the class of objects to have as wide a range as possible; as proficiency increases, the time allowed for preliminary observation to be shortened, until the briefest possible glance at an object shall be sufficient to impress its appearance clearly upon the mind, the power of visualization becoming so highly cultivated that at any future time the image may be called up and reproduced with absolute fidelity of detail; as a modification of the foregoing, drawing objects from description, oral and other.

Second. Other exercises of the same general character, with or without the aid of drawing, having reference to other characteristics than form, as, for example, material, structure, and function.

Third. The solution of problems pertaining to the construction of the sample object, its manufacture and improvement, together with the discovery of means for the accomplishment of definite ends. These are, of course, merely suggestions, the scope of which may be extended and modified almost indefinitely. It may perhaps be objected that, while the first and second of the exercises above suggested might have the effect of cultivating the mental capacity for accurate observation, retentive memory, and clear visualization, the third would often prove to be beyond the scope of the ordinary mind. That such is not the case I am able to show by citing as an example the invention of an actual machine of no inconsiderable utility, for the purpose of assembling fruit-cans in the process of manufacture. For convenience of description the experiment is thrown into the form of a colloquy.

Q. Of what shape is a fruit-can? *A*. Cylindrical.

Q. What is the principal peculiarity of the cylindrical form? *A*. Roundness.

Q. What does this adapt it to do? *A*. Roll on a plane surface.

Q. To provide means of conveying cylinders a short distance in the simplest manner, how would you proceed? *A*. Make an inclined plane.

Q. Then, to convey bodies and heads of cans to a place to be operated upon, what would you provide? *A.* Inclined planes.

Q. Suppose you had to unite two pieces of stove-pipe in the usual way; how would you go about it? *A.* Hold them carefully opposite each other; then shove them together.

Q. Suppose you had to unite many such pieces of stove-pipe in lengths of two, and to do it quickly? *A.* Fix something that would hold them opposite each other, and then shove them together.

Q. Now, with regard to the tops and bottoms of fruit-cans; how would you assemble them? *A.* The same as stove-pipes.

Q. How is that? *A.* Let them roll down into something which will hold them in line with one another, and then shove them together.

Q. How will you make room for the next ones? *A.* Let the finished ones roll away.

Q. How would you instruct a mechanic to build your machine? *A.* Make three inclined runways, one for the can-bodies and one on each side for the covers. At the lower end of the runways, make something that will hold these three things in line with each other. Then fix something that will push all three together, and make a runway for the finished cans to roll away.

Will any one deny that the above course of reasoning is not within the capacity of an intelligent boy of 12 years of age, or that a mechanic skilled in the construction of such machinery could not build a practically operative can-heading machine from the above specification?

A course of instruction such as I have attempted to outline would serve to confer upon all capabilities now enjoyed only by the few, and would give to them such capacities for dealing with novel and unexpected problems and conditions as would vastly increase the productive capacity of the community. Language fails me in attempting to express my sense of the vast importance and urgent necessity of systematic culture and education in the direction which I have indicated. The Science of Invention should take its place as the first study in the kindergarten, and the test of proficiency therein should be the last one to which the student should be subjected before leaving his Alma Mater to struggle with the ever new problems which will surely confront him in actual life.

It requires far more than the necessarily brief space which can be allotted to a magazine article to treat this subject in the manner which its importance demands, but I trust that enough has been said to show that such a course of training, if generally adopted, would vastly increase the dominion of man over the forces of nature, and immeasurably hasten the advent of the real Age of Invention.

ILLUMINATING GAS FOR HEATING PURPOSES.*

By Frederick Siemens.

THERE is hardly any more important and more difficult question to be solved than the rational heating of dwellings. This is evident from the fact that, though many systems and constructions have been applied, not one exists which meets all the requirements.

A heating appliance must be cheap, not only as to first installation, but especially as to operating expense; it must be easy to attend to, and must not require any intelligent attendance; and, above all, it must be agreeable, and not detrimental to the health. Furthermore, it must be easily regulated, preferably by an automatic device, and must not cause any nuisance outside; for instance, it must not evolve any smoke,—that being very often the cause of complaints in otherwise good heating installations.

How are these requirements met in practice? The first installation is too expensive in most of the central heating systems, which show lesser or greater deficiencies according to the system employed. The hot-air heating system has a very disagreeable effect on the organs of respiration, for the reason that the air is hot and dry; from a hygienic standpoint, therefore, it is to be condemned, because the air which we breathe should be cool and nearly saturated with moisture. On the other hand, the existing systems are too expensive in operation, as, for instance, the English grate, which probably best meets the hygienic requirements in a dwelling, but which vitiates the air of the neighborhood—at least in large cities—with the escaping smoke and other products of combustion. The English grate heating system is very expensive on account of the large waste of fuel, and because it makes necessary a continuous care of the grate; in other respects it is agreeable and comfortable, mainly because only *radiating heat* is employed, similar to the heat from the sun, which is certainly the most agreeable and hygienic heat. Heating by large porcelain tile stoves is cheap, but from a hygienic point of view it is bad, as almost no radiating heat is obtained. The convection of heat by means of these large, moderately-heated porcelain stoves is effected in the main by the circulation of the air, as the air in the room rises against the heated surfaces of the stove and falls against the cooler walls of the room.

---

* Translated by F. B. Badt from a paper read before the Eighth International Congress for Hygiene and Demography.

The advantage of the porcelain stoves consists in the moderate degree to which the surfaces of the stove are heated, but from a hygienic point of view this mode of heating must be condemned, because the effect is about the same as that of the hot-air system. The circulation of the air, as described, heats the air of the room, while in the English grate system the radiating heat leaves the air of the room cool, but, on the other hand, heats the walls and all the objects in the room in exactly the same manner as the sun heats everything in nature. Another very uncomfortable, but simple, method of heating is by means of the so-called "Cannon" stoves. These stoves are usually made of iron; they get very hot on the outside, and therefore radiate much heat; they act less by heating the air than by radiation, but they vitiate the air in the room in other respects to a very high degree. The heated iron permits the poisonous gases of combustion (for instance, carbonic acid gas) to pass through it; besides, the air in the room rises against the hot surfaces of the iron stove as in the case of the porcelain stoves; only the air gets heated to such a degree that it burns and carbonizes many particles of dust composed of organic substances always prevalent in air. This causes a highly disagreeable odor, which will always be found where stove surfaces heated to a high degree are exposed to the air of the room.

I classify under the heading "Cannon" or "Iron Stoves" all stoves whose external surface is heated to more than 212° F· These iron stoves exist in innumerable types, and are made under many systems, but are usually employed only as makeshifts, it being unbearable to any human being to breathe for any length of time the half burned and singed organic matter contained in the air.

It can be easily seen that the temperature of the surface of a stove should be kept below 212° F. This is the reason that in all countries with cold and long winters, where the necessity for heating apparatus is the greatest, the large, moderately-heated porcelain stoves are generally used; while in countries with moderate winters the iron stoves prevail, because heating apparatus is used rather exceptionally. In all central heating systems the low-pressure steam heat is preferred, although the first cost and the operating expenses are comparatively high on account of the large heating surfaces needed. The air under system is more agreeable and healthful than in cheaper installations, which operate with smaller heating surfaces and higher temperatures.

I might go into still more detail in these comparisons, but I assume that I shall be readily understood when I say that, for heating dwellings, the ideal apparatus is one which generates a large amount of radiating heat, but exposes only very moderately heated surfaces. This leads me to the consideration of the regenerative gas stove, which was constructed to meet these ideal conditions. As a common gas flame does not radiate over 30 per cent. of its heat, I increase this percentage by using an intensely white regenerative gas flame, similar to that used for lighting purposes. Such a flame radiates, on account of its much higher temperature, at least twice as much heat as does the common gas flame; however, the escaping products of combustion of the very hot flame convey less heat to the stove, because the regenerator absorbs most of the heat of combustion for the purpose of heating the necessary amount of air previous to combustion.

In order to make myself clear on the subject, I want to state that I commenced about twelve years ago to manufacture heating stoves for illuminating-gas and with regeneration of heat, which were also called accumulators. In 1885 I obtained my German and other patents, and I then commenced to offer such stoves to the public. The result was that a good many competitors appeared, offering stoves to be used with illuminating gas, partly with and partly without radiating heat, but all without a heat accumulator. In the beginning these gas-heating stoves did not find favor, partly on account of the erroneous supposition that the use of illuminating gas would be too costly, and then because the intensely illuminating regenerative gas flame had a blinding effect on the eye. When, finally, a few years ago, during the Brussels Exposition, such a stove, without a regenerator or accumulator, made its appearance, in which the heating radiating gas flame was invisible, but gave its effect indirectly by means of a copper reflector, it found more favor with the public. Since the appearance of the indirectly operating reflector, which I employ also, the demand for regenerative gas stoves has increased considerably, in spite of the many competitors who do not employ regenerative apparatus, but succeeded nevertheless in selling a good many stoves on account of their cheapness, and because they called them "regenerative" or "double regenerative." I would not care about this competition if the public were not deceived by cheap stoves, falsely called regenerative, thereby injuring the reputation of the system. As it would take too much space to relate the whole business development of my heating system, I confine myself to its description as it stands to-day.

The drawing (Figs. 1 and 2) shows, in two cross-sections, that the heating apparatus consists of two main parts,—*viz.*, the simple radiating grate arrangement "A," and the stove "B," which is built over the grate for the complete utilization of the remaining heat. The gas heating flame is formed by leading illuminating gas through the horizontal pipe "v," which is located above the reflector "r"; the pipe contains in the forward direction one or more fine holes through which the gas can escape in horizontal flames.

The air necessary for combustion flows in the beginning, when the apparatus is cold, out of the space in front of the reflector to the burners. The flames are pointed horizontally and forward (compare drawing), and radiate a great deal of their heat on the reflector "r"; then they are led through the downward channel "m" of the regenerator "C," and then again forward through the channel "n" in the upper part of the stove "B," and finally escape through the stove pipe "E." In leading the products of combustion downward the regenerative apparatus is heated as contemplated. The necessary air of combustion, which is of course cold, enters now through the vertical regenerator channel "e" from below; the air then moves in a direction opposite to that of the products of combustion, which are moving downward in shaft "n," and in this manner the air absorbs the greater part of the heat of the products of combustion; then, highly heated, the air mixes from above and below, with the gas escaping out of pipe "v." The air channel "e," on account of its heating by the product of combustion and on account of its almost vertical position, becomes a small chimney, and conducts the hot air to the gas flames automatically,—*i. e.*, independently of the main chimney "E." This automatic conveyance of the hot air is a highly important requirement, because the whole heating apparatus becomes independent of the unreliable draught of the chimney, and may be employed even where there is no chimney at all. In the latter case, however, the products of combustion would escape into the room, which must be obviated for hygienic reasons. The products of combustion, already considerably cooled in the regenerator "C," now heat, in the moderate manner desired, the upper part of the apparatus, the real stove "B," which consists of a number of boxes (k k k) so arranged that they leave spaces and constitute a large extended heating surface, in order to utilize in the best possible manner the remaining heat.

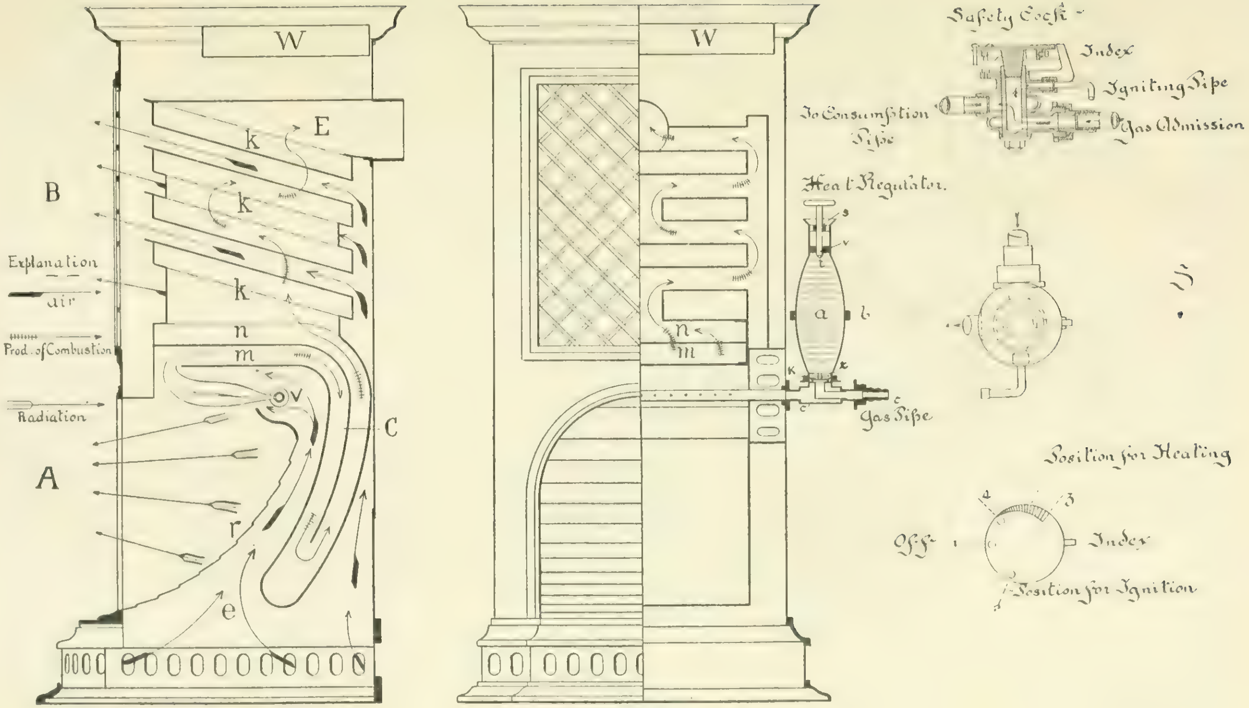
Provision is also made for the evaporation of water in the upper part of the stove, in order to saturate to a certain extent the dry air generated by the stove "B."

An important part of the whole heating apparatus is the reflector "r," which, as can be seen from the drawing, is so arranged that the rays of light and heat falling on it from above are reflected forward and sidewise, while the intense white flame itself cannot be seen from the room.

By means of the reflector, whose material, color, and surface are so selected that the rays of heat are thrown completely into the room without disturbing the eye by the rays of light or the images of the burners, the room is mainly heated in the lower part, so that at the height of, say, 5 ft. the temperature is considerably lower than at the floor. By such an arrangement the comfort is greatly increased and a waste of heat is prevented,—a waste which must exist when, as in the other heating systems, the ceiling of a room is heated while the floor remains cold. I describe the upper part of the heating apparatus, the real stove "B," only superficially, because this part does not show any novelty and might even be omitted under certain conditions. Where considerations of the greatest economy do not exist, it might be well to use only the lower part of the heating apparatus, the real grate "A," with its excessive radiation of heat. With the small surfaces of the stove "B" and with its low degree of heat, the effects of the stove must be the same, though in a small degree, as in the large porcelain stove already described. As, by means of the regenerative system, a much greater part of the heat generated by combustion is converted into radiating heat and led to the room in the most advantageous manner, it is the more advisable to do away with the stove "B." Lately this arrangement has met with much favor, especially in the more luxurious dwellings.

Another highly important advantage, which is made possible only by the application of illuminating gas for the generation of heat, consists in the possibility of the application of an automatic regulator. This heat regulator, which may be adjusted for any desired temperature, raises or lowers the temperature by permitting more or less gas to flow to the burners. This arrangement not only adds to the comfort, but prevents the waste of gas. It is fair to assume that the consumption of fuel in all other heating systems is increased by the lack of an automatic heat regulator, because the heating is effected without regard to the existing temperature. The consumption of fuel, of course, could be diminished if an economical mode of heating were adopted, but this is not alone sufficient; it is necessary also to adjust the heating in accordance with the continually changing demand for heat. As the automatic heat regulator permits the use of fuel in exact proportion to the momentary demand, and as the generated heat is directed by means of the reflector to the place where it is needed, the gas heating stove shows an actual saving in fuel in comparison with all other systems, in spite of the comparatively high price of illuminating gas.

The heat regulator constructed by me is illustrated in Fig. 2. It consists of an oval metal vessel "a," to which is attached below a telescoping arrangement "z," made out of thin tin. To the lower end of the telescoping arrangement is attached a small cone "k," which serves to regulate the flow of gas through the pipes "c" and "c^1," "c" being inside of "c^1." Pipe "c" is connected with the gas service pipe, and "c^1" with the stove. The flow of the gas is


W
E
k
k
k
n
m
v
C
r
e
B
A
Explanation
air
Prod. of Combustion
Radiation
W
n
m
a
b
s
v
t
x
K
c
c
Gas Pipe
Heat Regulator.
Safety Cock
Index
Igniting Pipe
Gas Admission
To Consumption Pipe
Position for Heating
Off
1
2
3
4
Index
Position for Ignition

indicated by the arrows. The vessel "a" is provided in its upper end with a small pipe "r," which terminates in a little funnel "t"; the latter contains a little needle valve "v," which may be opened or closed by means of thumb-screw "s."

The whole apparatus is filled with water in such a manner that the water becomes visible in the funnel and does away with air bubbles. Hoop "b" may be compressed by means of a screw, thus compressing vessel "a" more or less, so that the water in the funnel will visibly rise or fall.

Just as soon as the whole apparatus is regulated so that cone "k" at a certain temperature, say 54° F., with the needle valve "v" closed, permits a sufficient amount of gas to pass, the water in vessel "a" will expand with any rise of temperature; this will cause the telescoping arrangement to move cone "k" in a downward direction, and consequently the flow of gas will be partially or entirely shut off. If the water in the vessel "a" cools, the telescoping arrangement will contract, and the cone "k" will again permit the passage of the gas in proportion to the degree of temperature.

The advantage of such a temperature-regulator over other well-known devices lies in the fact that, in case of escape of the liquid, which will occur in the course of time, the needle valve "v" may be opened, and water may be added through the funnel "t," until the apparatus is again properly adjusted.

Another important device is the safety cock "s" with self-igniter. (Fig 3). This cock is so constructed that it can be turned only in one direction and only step by step. If the index points to step 1, the cock closes. If the index turns to step 2, the igniting flame touches the gas service pipe. The next step connects the gas service pipe with the main flame. This is ignited on the igniting flame, and the latter is again shut off, so that, when the index points to step 3, only the main flame is burning and the ignited flame is shut off. Between steps 3 and 4, the hand may be moved to and fro for the admission of more or less gas, as indicated by the scale.

If it becomes necessary to extinguish the flame, the index is set to 1. Such a safety device is very important, because without it negligence and ignorance may cause many bad results. Even malicious intent could cause an irregularity only when assisted by technical knowledge.

In closing this paper, I beg to draw your attention to the fact that probably illuminating gas will be superseded to a very large extent by the electric light. It is, however, a rather curious coincidence that electricity for heating can find only a limited application, while, on the other hand, illuminating gas is particularly adapted for it. The illuminating gas as fuel is not only applicable for heating stoves, but for all feasible domestic and technical purposes ; it is well adapted for cooking, melting, annealing, and other operations. It has become more and more evident that illuminating gas is particularly adapted for heating purposes on account of its great radiation of heat, radiating heat being the best for heating purposes. Where heating by contact is required, we may apply the Bunsen or similar burners, so that even for these purposes the illuminating gas can be used to advantage. I beg to remind you of the Auer incandescent light, and various cooking and heating apparatuses.

In most of the heating and melting operations, especially in all cases where the regenerative system can be used with advantage, it is the radiating heat that we want, as I pointed out some years ago in my many papers read in Germany and England. I refer to these papers and the many successes which I have achieved with my regenerative gas stoves in many technical industries, especially in the glass and steel industries.

I think I may predict that the present illuminating gas will gradually change its *rôle*, and will be used in future mainly as fuel. Especially in large cities would this change be advantageous ; but, in order to obtain this result, the illuminating gas, or, rather, the heating gas, must be considerably reduced in cost. Prospects for such reduction are good, because gas prices have been continually on the decline, and larger competition and the great progress made in the methods of manufacturing gas will contribute their share, especially if the gas is used to a larger extent for heating purposes.

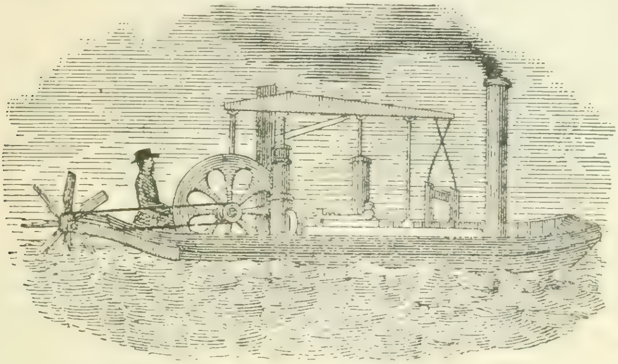
ROBERT FULTON AND HIS STEAMBOATS.

By T. C. Purdy.

TWELVE years from this August we may celebrate the centennial anniversary of the first trip of the steamer "Clermont" up the Hudson river. It is to be hoped that the event will be commemorated with a grand pageant of modern steamers, proceeding over the historic route; and among them, I trust, will be found some large vessels propelled by stored electricity, thus opening the century as propitiously with this new force as the ending century was opened by Watt, Fitch, Fulton, Stevens, and Symington. In view of the possibility of such a celebration, we may discuss Robert Fulton and his work, in order to form a correct estimate of the man and ascertain the bearing of certain data upon the important events of his life.

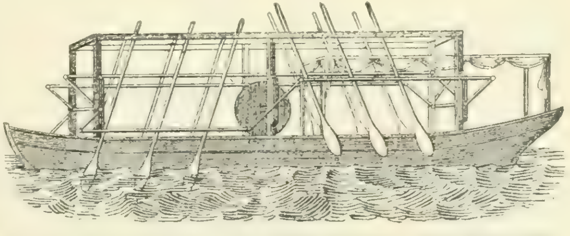
According to a writer quoted by Admiral Preble in his "History of Steam Navigation," Fulton named the Clermont the Katharine of Clermont, after Katharine Livingston, of Clermont Manor. August 7, 1807,—the date usually given for the starting of the Katharine of Clermont on her first trip from New York up the Hudson,—was Friday, and it is certain that the voyage was not begun on that unlucky day, but that it took place on the 17th of August, some careless writer having dropped the 1 from the number 17, thus causing August 7 to be accepted as the date by many historians. August 17, 1807, was Monday, and Fulton published a letter in the *American Citizen* describing the trip, in which he says: "I left New York on Monday at 1 o'clock, and arrived at Clermont, the seat of Chancellor Livingston, at 1; time, 24 hours; distance, 110 miles. On Wednesday I left the chancellor's at 9 in the morning, and arrived at Albany at 5 in the afternoon; distance, 40 miles; time, 8 hours. The run is 150 miles in 32 hours,—equal to nearly five miles an hour. On Thursday at 9 o'clock in the morning, I left Albany, and arrived at the chancellor's at 6 in the evening. I started from there at 7 and arrived at New York at 4 in the afternoon; time, 30 hours; space run through, 150 miles,—equal to 5 miles an hour. Throughout my whole way, both going and returning, the wind was ahead. No advantage could be derived from my sail. The whole has therefore been performed by the power of the steam-engine," etc.

A letter from a South Carolina gentleman, published in the British *Naval Chronicle* and written under date of September 8, 1807, says: "I have now the pleasure to state to you the particulars of a late excursion to Albany in the steamboat made and completed under the direction of the Hon. Robert R. Livingston and Mr. Fulton. On the morning of the 19th of August, Edward P. Livingston, Esq., and myself were honored with an invitation from the chancellor and Mr. Fulton to proceed to Albany, in trying the first experiment upon the Hudson in the steamboat. She was then lying off Clermont, the seat of the chancellor, where she had arrived in 24 hours from New York, being 110 miles."

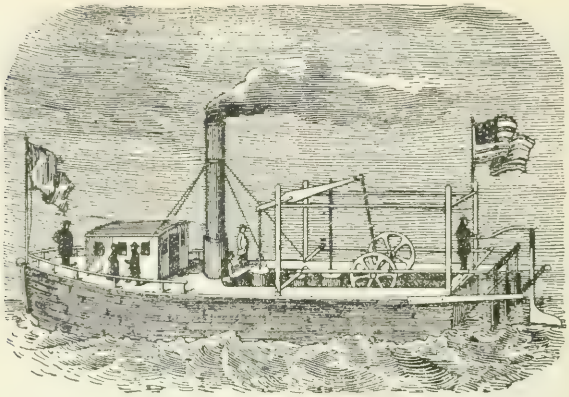


THE EROKTAE AMPHIBOLIS. OLIVER EVANS—1804.

In justice to other inventors, and to arrive at a correct estimate of Robert Fulton's part in the development of the steamboat, we may discuss his merits as an inventor, adapter, and shrewd business man, ready to take advantage of any suggestion at hand and of results attained by others in this line of invention. It is a historic fact that he had made himself familiar with the discoveries in the use of steam up to the date of his successful experiment, and was thus able to avoid the errors that other inventors had made. No class of brainworkers suffer more from plagiarism than the engineers of this country, and they will readily sympathize with John Fitch in this wail taken from his journal: "The day will come when some more powerful man will get fame and riches from my invention; but nobody will believe that poor John Fitch can do anything worthy of attention." In 1785 Robert Fulton was living in Philadelphia, following the vocation of a miniature painter, and was undoubtedly familiar with the work that Fitch had done there, as it had been made public before he left that city. Later, it is claimed, he had Fitch's drawings in his possession while living in Paris. English writers declare that in 1801 he visited Symington's boat on the



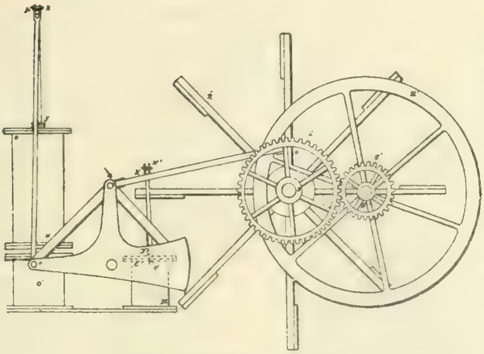
FITCH'S SECOND BOAT—DRIVEN BY PADDLES, SIX ON A SIDE; AS SIX CAME OUT OF THE WATER SIX MORE ENTERED.



FITCH'S THIRD BOAT—DRIVEN BY PADDLES AT THE STERN.

Forth and Clyde Canal, and made drawings of the machinery and took an 8-mile trip on her, going at the rate of 6 miles per hour. He also met a Dr. Cartwright in England, who had made experiments in steam navigation, and who confided his plans to him. Thus armed, and backed by Chancellor Livingston and his money, he produced the Katharine of Clermont and became famous. He never made a strong claim to the invention of the steamboat, but claimed the perfection of its machinery and the adjustment of its parts. After Fulton's death, which occurred on February 24, 1815, the Fulton Steamboat Company was organized under the laws of the State of New York, on April 18, 1815, with a capital of. $250,000 The following is a list of the boats constructed by Fulton and his associates in this company:

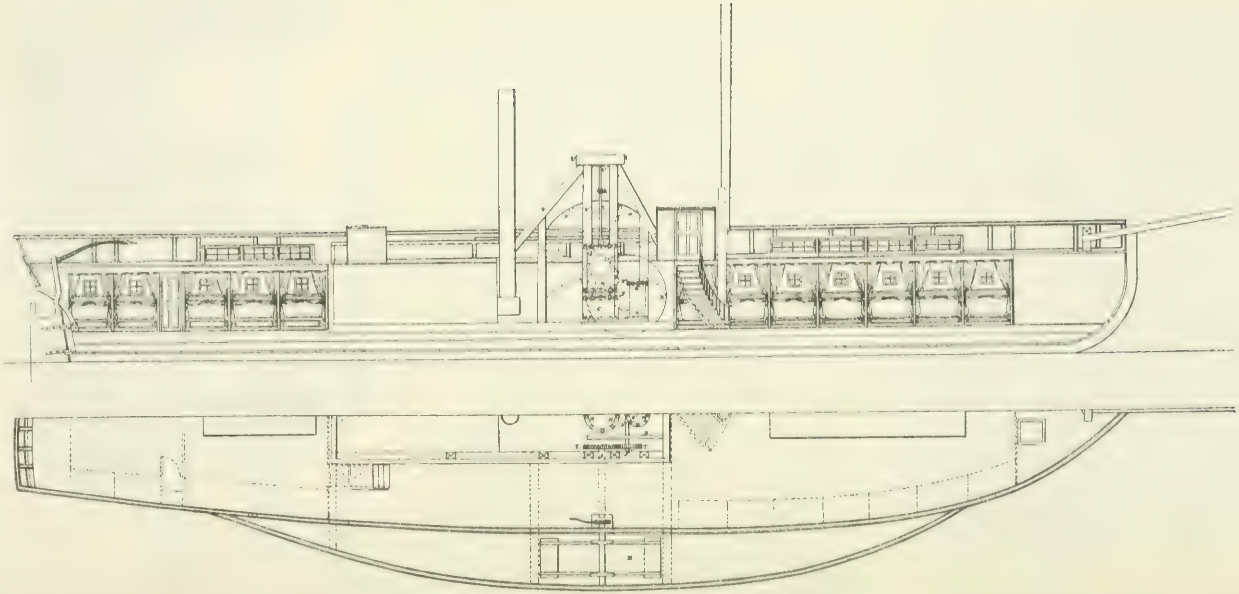
Name.	Year.	Tonnage.	Route.
Clermont	1807	160	Hudson River.
Car of Neptune	"	295	" "
Raritan	1808	120	" "
Paragon	1811	331	" "
Fire Fly	1812	118	New York to Newburgh.
Jersey (Ferry)	"	...	" " " Jersey City.
Richmond	1813	370	Hudson River.
Washington	"	275	Potomac River.
York (Ferry)	"	...	Jersey City and New York.
Nassau "	"	...	Brooklyn to New York.
Fulton	"	327	Long Island Sound.
Fulton First	1814	2475	United States Navy.
Olive Branch	1816	265	New York to New Brunswick.
Connecticut	"	351	Long Island Sound.
Chancellor Livingston	"	495	Hudson River.
	AT PITTSBURGH.		
New Orleans	1811	371	Mississippi River.
Vesuvius	1814	340	" "
Ætna	1815	360	" "
Buffalo	"	249	" "



THE CLERMONT GEARING.

With the destruction of the public buildings at Washington by the British in 1814, we lost all of the drawings and specifications of the early American inventors. We therefore possess but very meager information of an authentic character regarding the construction and modeling of the early steamers. The French government became interested in the wonderful development of steam navigation in this country, and sent an engineer here in 1822 to make a report. There is but one copy of this report in this country; I have had tracings of the drawings made, and have translated a portion of the text with a view of publishing it in the form of a history, but have not done so as yet. These drawings and records give the most authentic information that we now have in this country; they were the work of an expert, and covered the field with no bias for the work of any particular inventor. These drawings would enable us to reconstruct some of Fulton's masterpieces, like the Fulton, or the Chancellor Livingston. The hull and engines of the one and sectional and deck plans of the other are herewith presented pages 872 and 874. The Livingston was undoubtedly the most complete of Fulton's steamers, though she was finished after his death. Great care was taken in her construction, and nothing was spared to render her superior to all other boats of her day in the luxury of her appointments. She was sheeted with copper, and cost $128,000. The principal part of the engine was placed in the middle of the hull, and the rest of the machinery aft. The cylinder was 40 in., with a stroke of 5 ft.; and up to 1820 she was the only steamer in

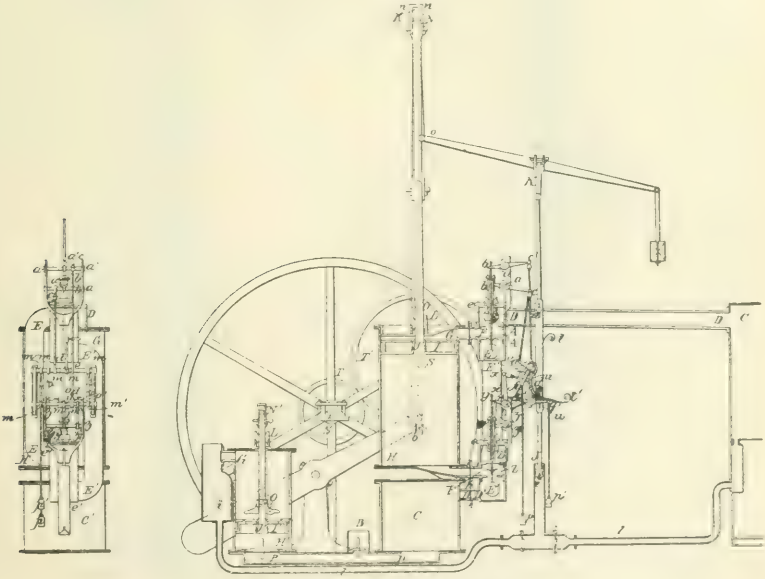
SYMINGTON'S BOAT, DRIVEN BY A STERN PADDLE-WHEEL.



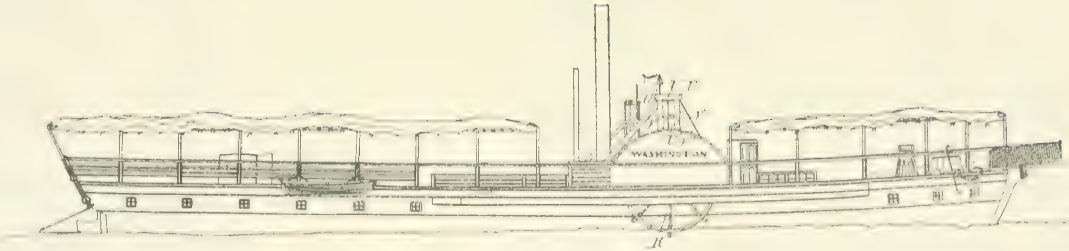
THE FULTON, LONG ISLAND SOUND, 1813.

the Eastern States in which coal was used. She ran from New York to Albany in 20 hours,—a distance of 150 miles, the wheels making seventeen revolutions per minute. Nearly all the engines in the Eastern States in 1820 were modifications of that in the Chancellor Livingston shown below. It was a low-pressure engine taking the steam at both ends of the cylinder. The principal cylinder, *GH*, was vertical,—the condenser, *C′*, beneath, and to the right a portion of the boiler, *C*. The connecting pipe, *D D E E*, carried steam from the boiler to the cylinder, and two valves, *A*, and *Z*, admitted it, one above and one below the piston, *I*, and two other valves, *A′*, and *Z′*, let it pass out into the pipe, *E′ E′ D′ D′*, which led to the condenser, where it was met by a jet of cold water. This water, air, and vapor were then taken up by the air-pump, G′ H′, through the pipe, *P P*, into which the valve, *B*,′ opened, and carried into the hot well, *i′* and through the force pump thrown back into the boiler, *C*.

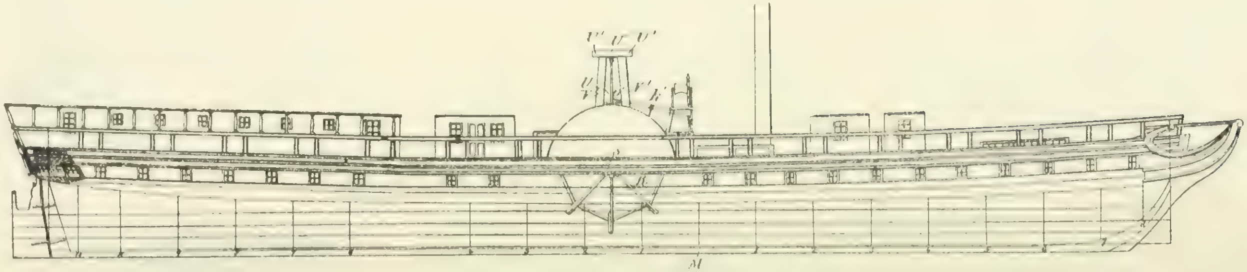
On page 874 is given a correct drawing of the hull of this famous boat. In 1832 she was bought by Mr. Cornelius Vanderbilt and Mr. Amos H. Cross of Portland, and put upon a route between that city and Boston. At that time she had her third engine, which was a square or cross-head engine. In 1834 the Chancellor Livingston was broken up, and her engines were placed in the Portland. On



ENGINE OF THE CHANCELLOR LIVINGSTON.



THE WASHINGTON — 1813.



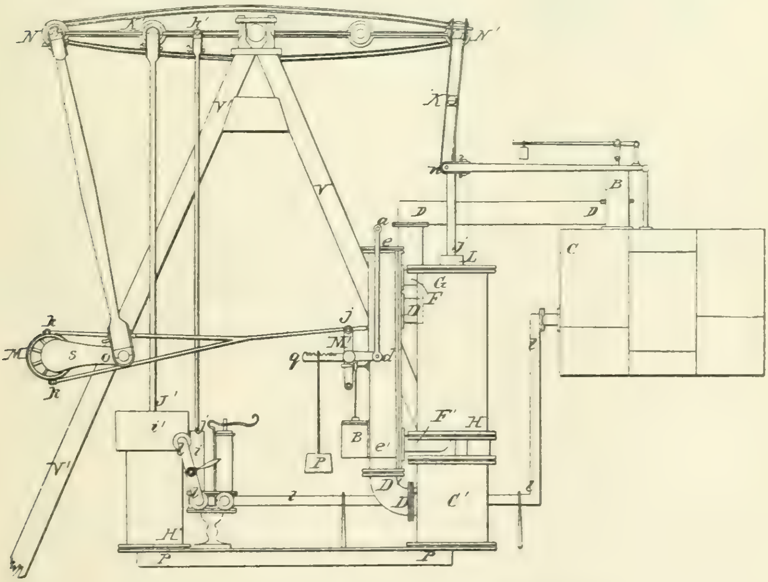
THE CHANCELLOR LIVINGSTON — 1816.

page 872 are presented the deck plan and a sectional view of the steamer Fulton, of 327 tons and built in 1813. According to the French government report, the Fulton cost $93,000, and the boiler alone is said to have cost 32,000 francs. It was 20 ft. long by 8 ft. high and 9 ft. broad. The mechanism of the engine did not differ much from that of the engine in the Chancellor Livingston. The Fulton ran from New York to Albany in 28 hours and 20 minutes. In 1814 she ran on a route from New London to New Haven, making 52 miles in 10 hours 43 minutes. She burned about 25 cords of wood on the trip. All the dimensions of her machinery are given in this report.

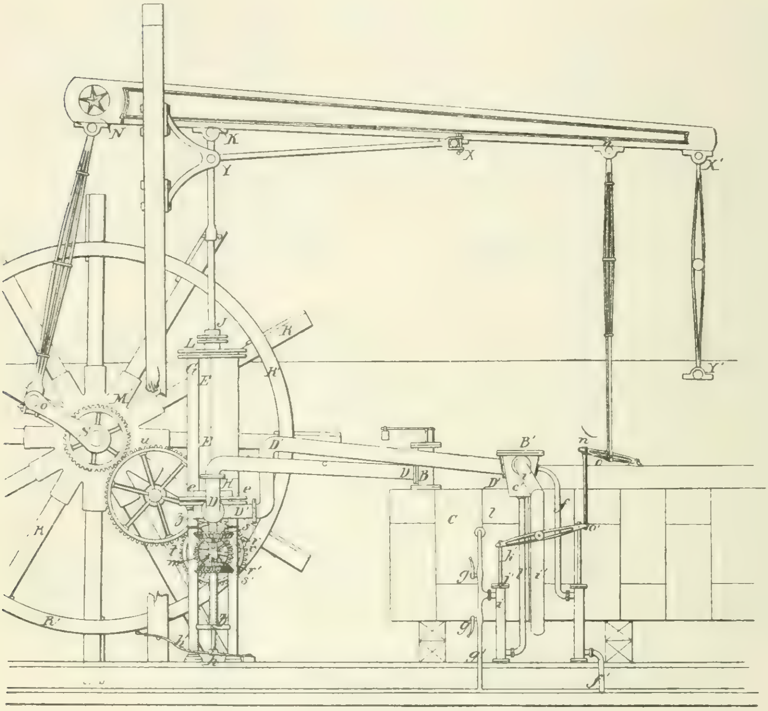
Below is given an Allaire engine, built for a Mississippi river boat in 1818. The parts will be readily understood. All the engines of this date were parallel motion engines, as will be seen by the drawings; only low-pressure engines were used in Fulton's boats.

On page 874 is given the hull of the Washington. She was built in 1813, and was brought around from New York into the Potomac in 1815. She cost $42,000, and was not sheeted with copper. The engine was 32 h. p. with a cylinder of 28″ and 4-ft. stroke.

A correspondent of the *National Intelligencer*, writing from Norfolk under the date of May 24, 1815, gives the following relating to the trip of this steamer from New York to that port. "We were last evening,



ENGINE FOR A RIVER STEAMER, ALLAIRE, 1818.

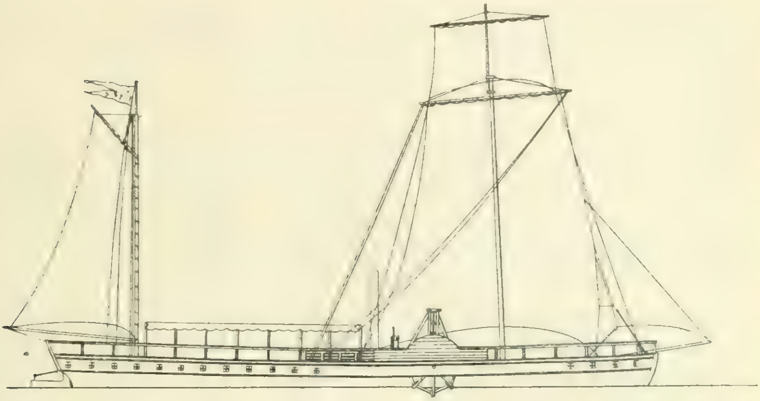


ENGINE OF THE ÆTNA. BUILT BY OLIVER EVANS—1815.

for the first time, gratified with the sight of a steamboat entering our harbor. The distinguished stranger is called the Washington, commanded by Captain O'Neal and owned by a company of gentlemen at Washington. We were in hopes that she would ply between this place and Richmond, but understand she is destined for the Potomac. On leaving New York, many were doubtful, thinking that she would not be able to perform the voyage, no vessel of that class having tried the sea before; but she made the trip in perfect safety, in a period of 50 hours. Her cabin is superbly fitted up with every convenience for the comfort and accommodation of passengers. Capt. O'Neal has politely favored us with New York papers of Saturday, 2 days later than those by mail."

She made the run from Norfolk to Washington in 30 hours, arriving there on June 1, 1815. She went on a route to Fredericksburg. She was followed by the Potomac in 1820, which ran between Washington and Norfolk.

No figure stands out with more prominence in the early history of



THE PARAGON—HUDSON RIVER—1811.

steam navigation in this country than that of Oliver Evans, the father of the high-pressure engine. On page 876 is shown one of his engines, —that of the steamer Ætna. This steamer was built in Philadelphia in 1815. She was 116 ft. long and measured 125 tons. Her engine was of 45 h. p., with a 20″ cylinder and a paddle-wheel 18 ft. in diameter, with a rim of cast iron serving in the place of a balance-wheel. The boiler, composed of several cylinders, was 23 ft. long and 8 ft. 6 in. in diameter, and was said to sustain a pressure of ten atmospheres. Nearly all of the engines in this country up to 1820 were low-pressure. In the engines of the Ætna, however, the pressure was raised to several times that of the atmosphere. Oliver Evans built engines at Philadelphia up to 1819, when his works were burned; he died April 21 of that year.

While honoring Robert Fulton for making a success of the steamboat, let us not forget that, like nearly all great inventions, it was a growth; many good men assisted in its development, and among them, deserving great credit, were John Fitch and Oliver Evans.

JAMES RUMSEY, STEAMBOAT INVENTOR.

By James Weir, Jr.

TO Robert Fulton is generally given the credit of having discovered the first method of propelling vessels through the agency of steam; yet it can be clearly shown that two men antedated him, even here in America, in this discovery. One of them preceded him by almost 20 years, the other by 18 or 19 years.

The man who, in America, first discovered a method of successfully propelling a vessel against wind and tide, with steam as the motive power, was James Rumsey. The government of the United States has recognized this to be an established fact, for in 1839 congress ordered a medal to be struck in his honor, commemorative of this brilliant achievement. James Rumsey was born of Scotch parents in 1754. Maryland was his native State, but he removed to Sheperdstown, Va., when about 20 years of age. He had all the native shrewdness and astuteness generally ascribed to the Scotchman. He was a man of fine presence, tall and powerfully built. While, strictly speaking, not an educated man, he was an omnivorous reader and well versed in matters pertaining to his profession,—civil engineering. He was a good talker, but a better listener, and his neighbors regarded him with respect and looked upon him as a man of undoubted genius. He early turned his attention to invention, and the writer had, until a short time ago, a pistol made by him, which shows his inventive capacity.

When Rumsey removed from Maryland to Sheperdstown, he entered the service of the Potomac Company as superintendent. While in the service of this company, he suggested many novel views in mechanics, and invented and put into operation numerous improvements in milling, especially in the application of hydraulics as the motive power. The steam engine was then in its infancy. Watt was just beginning to perfect his wonderful invention. Machinists were rude and unskilled in their profession, and Rumsey was forced to plan, model, and make his own machinery. He even did his most important casting himself,—making the moulds and running off the metal with his own hands. Testimony adduced before the house of representatives in 1839 shows that Rumsey had conceived the idea of steam-navigation as early as August, 1783 (*Cong. Record*). Laboring under very adverse circumstances, he succeeded in the autumn of 1784 in making a test of some of the principles of his engine and propelling apparatus. In October, 1784, the Virginia legislature passed an act "guaranteeing to him the exclusive use of his invention in navigating the waters of Virginia" (Stat. Virg., 1784). About this time he wrote to General Washington, communicating to him the principles of his invention. General Washington wrote of Rumsey's invention to Governor Johnson of Maryland. This letter is dated November, 1787, and was produced before a committee of the house in 1839, at which time the following resolution was offered and passed :

> *Resolved, by the Senate and House of Representatives of the United States of America in Congress assembled :* That the president be, and he is hereby, requested to present to James Rumsey, Jr., the son and only surviving child of James Rumsey, deceased, a suitable gold medal, commemorative of his father's services and high agency in giving to the world the benefits of the steamboat.

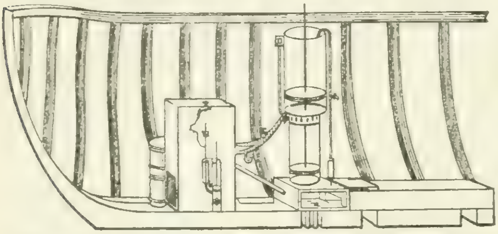
In January, 1785, Rumsey obtained a patent from the general assembly of Maryland for navigating the waters of that State (Acts Gen. Ass. Maryland, 1785). During the whole of this year he was busy in the construction of a steamboat. In 1786 he successfully navigated this boat on the Potomac at Sheperdstown in the presence of hundreds of spectators.* The experiment was eminently successful, as was proven by the affidavits and personal testimony of numerous witnesses who testified before the above-mentioned committee of the house in 1839. Mr. Bedinger described the experiment in a letter which was certified by Dr. Alexander of Baltimore, a man of eminence and respectability. Rumsey succeeded in this trial in propelling his boat against the current by steam, at the speed of *five miles an hour.* There was for a long time, and may be now, in the possession of one branch of the Rumsey family a pamphlet, which has been seen by numerous people well known to the writer, containing "approbatory certificates of numerous gentlemen who witnessed the exhibition." Among the names signed to certificates was that of General Gates. Mr. Bedinger mentions General Gates's presence in the letter read before the committee of the house, as detailed above. The result of this trial was very encouraging. Dr. Alexander, who was on board, said : "Every person present believed that Mr. Rumsey had accomplished all his wishes" (*Cong. Record*, 1839). This successful trial took place in 1786.

According to information in the possession of the writer, Rumsey's method of propulsion seems to have been exceedingly unique.

---

* The *Cincinnati Enquirer* lately printed the following dispatch from Parkersburg, W. Va., relating to the trial of Rumsey's boat : "The first steamboat was really built by James Rumsey at Sheperdstown, Va. (now West Virginia). The boat was partially constructed in Frederick county, Md., in 1785. It was fitted up with machinery partly manufactured at a furnace called 'the Catoclin,' owned by Johnson Bros., near Frederick, and the two cylinders, boiler, pumps, pipes, etc., were built in Baltimore. Part of the work was done at the old Antietam Iron Works. The boat was 80 ft. in length, and was propelled by an engine which worked a vertical pump placed in the center of the boat. The water was drawn in at the bow of the boat and discharged at the stern through a horizontal pipe. The weight of the machinery was 665 lbs., and the boat's capacity was 3 tons. All of the machinery, including the boilers, took up a space of only a little over 4 ft. square. The first public experiment took place on the Potomac river on March 14, 1786."

Through the instrumentality of a powerful steam pump, water was forced through a battery of tubes placed at the stern of the vessel. The streams of water, striking against the surface of the river, shoved the boat along.



Rumsey's second boat (1788), propelled by water jet at stern. - Partial section, showing steam engine, furnace for tubular boiler, force pump, inlet valves and ejection passage.

The only man who can contest precedence with Rumsey is Fitch. It can be clearly shown, however, that Fitch's first experiment was not made until September, 1788, two years after Rumsey's final and successful exhibition on the Potomac at Sheperdstown. DeWarville, an eminent French writer, says in his work that, "being in Philadelphia in September, 1788, he attended by invitation, and witnessed, Fitch's experiment" (DeWarville, Cong. Library). DeWarville, in a note written in February following, while in London, says: "I have just met Mr. Rumsey of Virginia, a gentleman of great ingenuity, who proposes building a vessel in which, without sails, and by steam alone, he will cross the Atlantic in 15 days." After his successful experiment in 1786, Rumsey resolved to go to England. He believed that, with better workmen and better opportunities, he could cross the Atlantic in 15 days, in a steamboat built after his plans. He believed also that he could find in London the money for the furtherance of his designs. Slender means, while in the great city, often occasioned him to fall back on other inventions, and to abandon for a time his pet scheme, the steamboat, in order to replenish his purse. After long delays and many disappointments, he at last succeeded in building a boat of 100 tons burden. His machinery was so near completion that he had fixed a day for public trial, when his sudden death from apoplexy, while lecturing before a philosophical society, put an end to everything. Dr. John Hunter, writing of mental emotion inducing apoplexy, refers to Rumsey when he says: "The person who invented or applied the steam engine to the sailing of ships, and, who, when it was before the committee of the Society of Arts and Sciences, was taken at once with an apoplectic stroke, of which he died in about 24 hours." (*Posthumous Papers*, vol. 1, p. 264.)

Rumsey's letters to Mr. West, his brother in-law, show that he and Fulton were on intimate terms in London. Fulton was in London for the purpose of introducing his torpedo, but after Rumsey's death turned his attention to the steamboat. It is definitely known that Fulton never gave a thought to the steamboat until after Rumsey's death This is shown in his letters to Lord Stanhope (Robt. Fulton Biog.). Fifteen years after Rumsey's death, Fulton succeeded in building a boat and running it against the current at the speed of five miles an hour. Rumsey, without assistance, without reflected light, did the same 20 years before. After Rumsey's death there was no one in his immediate family to attend to his numerous patents, and to push forward his inventions. His only son, James Rumsey, Jr., was blind and deaf from the effects of scarlet fever. His brothers possessed no mechanical or inventive faculties, and were engaged in other pursuits. The plans of this master mind ceased at his death, save only in the active brains of Fitch and Fulton.

Fitch was well acquainted with Rumsey's experiments, and had been present at the successful exhibition on the Potomac in 1786. He built a boat and successfully ran it in 1788. Fulton bided his time. Backed by Livingston, he made experiment after experiment, until in 1807 he perfected his arrangements and made a satisfactory trial of his steamboat. It is stated in Rees's Encyclopedia that Fitch made an experiment on the Delaware in 1783. This is not true; Fitch himself never claimed to have even thought of steam navigation until 1785. He made his first experiment on the Delaware in 1788 (DeWarville, Cong. Library). The testimony of General Bloomfield also fixes 1788 as the time of Fitch's experiment. (*N. Y. Review*, 1839.)

In the light of such testimony, we cannot fail to give the verdict of precedence to Rumsey, who successfully navigated his vessel, through the agency of steam alone, against wind and current on the Potomac in 1786.

ADDENDA.—These interesting contributions to the history of steamboat invention by Messrs. Purdy and Weir may be very appropriately supplemented by the following extracts from a little volume entitled, "Allegheny County's Hundred Years," by Geo. H. Thurston, published by Messrs. A. A. Anderson & Son, of Pittsburg, Pa., in 1888. From the chapter entitled "Boat Building in Allegheny Co.," beginning on page 99, we get the following interesting extracts.—THE EDITOR.

"Allegheny County is more than historically connected in a general way with the history of steamboat building. Elizabeth is the point where was built at the close of the eighteenth century the first sea-going vessel to navigate the western waters. * * * It would seem from the following extracts from the diary of one James

Kenny, a Quaker trader at Fort Pitt in 1761, that Pittsburg has some claims to being the place where the first germs of the idea of a steamboat originated. Says the diary:

"1761, 4th mo: 4th.—A young man called Wm. Ramsey has made two little boats, being squair at ye sterns, and joined together at ye stern by a swivel, make ye two in form of one boate, but will turn round shorter than a boat of ye same length or raise with more safety in falls and in case of striking rocks; he has also made an engine that goes with wheels enclosed in a box, to be worked by one man, by sitting on ye end of ye box, and tredding on treddlers at bottom with his feet, set ye wheels agoing, which work scullers or short paddles fixed over ye gunnels turning them round; ye under ones always laying hold in ye water, will make ye boate goe as if two men rowed; and he can steer at ye same time by lines like plow lines.

"There is nothing more on record of the young man called Wm. Ramsey, but the thought naturally occurs that, if he had persevered with his idea, Pittsburg was very near to being the scene of the first attempts to construct a boat to be driven with machine power. Where or when, however, the idea of a boat propelled by machine power or by steam originated is quite uncertain.

"From a work published about 40 years since in Spain, of original papers relating to the voyage of Columbus, preserved in the royal archives at Samancas, and those of the secretary of war in Spain, in 1543, it is stated that 'Blasco de Garay, a sea captain, exhibited to Charles V, in the year 1543, an engine by which vessels of the largest size could be propelled, even in a calm, without oars or sails. The emperor decided that an experiment should be made, which was successfully attempted on June 17, 1543, in the harbor of Barcelona. The experiment was on a ship of 209 tons, called the "Trinity." Garay never publicly exposed the construction of his engine, but it was observed at the time of the experiment that it consisted of a large cauldron of boiling water, and a movable wheel attached to each side of the ship.'

"A treatise was printed in London in 1737, describing a machine invented by Jonathan Hulls, for carrying vessels against wind and tide, for which George II granted a patent for 14 years. A drawing is prefixed to the treatise, showing a boat with chimney smoking, a pair of wheels rigged over each side of the stern. From the stern of the boat a tow line passes to the foremast of a two-decker, which the boat thus tows. This is evidently the first idea of a steam tow-boat. As this was a published treatise, and there was a patent on record, public information must have circulated of a steamboat before the experiments of Fitch or Fulton or Stevens or Livingston; and, while similarity of ideas in inventions is not infrequent, absolute originality is difficult to establish."

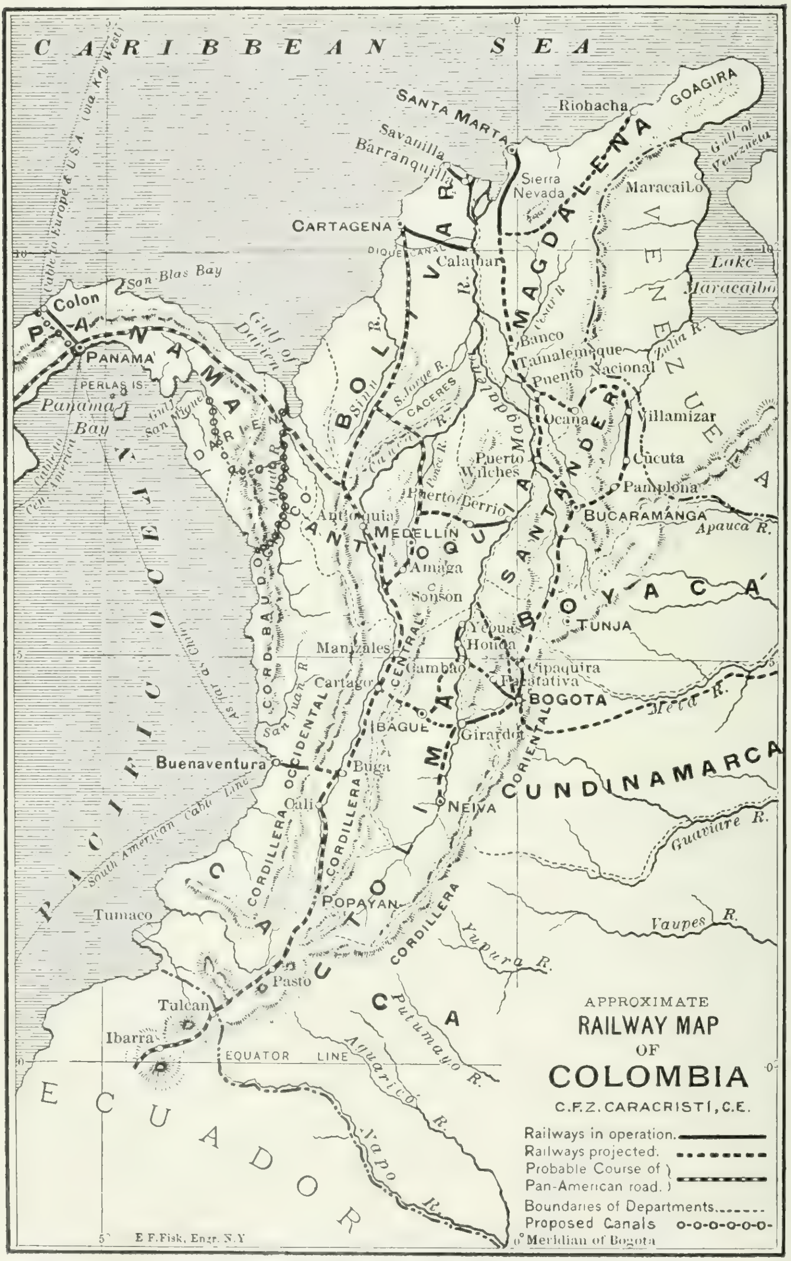
BUSINESS OPPORTUNITIES IN COLOMBIA.

By C. F. Z. Caracristi.

CONTINENTAL Colombia is a great, a beautiful, and a promising country, little resembling the isthmus of Panama, as is often mistakenly supposed. The isthmus is only the poorer part of Colombia,—in fact, the worst. At Bogotá, Medellin, and other large cities of the interior are found the polish and refinement of Paris. French and English are spoken with remarkable fluency, and the Latin classics are well understood. With the better classes, and among the *peons* as well, hospitality is one of the principal traits, and that courtesy and hospitality of which our own Southern people boast is overshadowed by the Colombians' chivalry and consideration. With them it is not a virtue to be hospitable, but it is almost a crime to be otherwise.

It is a sad reflection that many of the Americans and Englishmen who have received concessions from Colombia have turned out to be mere idle adventurers, without moral or financial support, who have dragged the concessions from pillar to post in the hope of realizing a few dollars. These people, with no record at home, who in many cases had been abject failures in their own countries, have repeatedly snared the confiding Colombians into giving them valuable privileges, which were offered for sale here, there, and everywhere until they lapsed and died of their own gravity. If a peanut-vender or street-fakir should enter a banking house, trying to float a foreign loan, he would be summarily ejected ; yet people of this or similar character have gone to Colombia, secured concessions, and brought them back to our bankers. The consequence has been absolute failure to place the enterprises, many of which have had value, and, if presented by men of standing, would have resulted in large profits to both promoters and investors, and the advancement of the country's material welfare. President Caro is a man of sterling honesty and pronounced ability, whose aim is higher than mere office for power. He is a scholar of renown, and deserves the earnest support of all honest Colombians, regardless of their political views. One of his strongest advisers, and by far the most unassuming of them all, has been the Hon. Marco Fidel Saurez, secretary of foreign affairs, a man courteous in manner, considerate in sentiment, and of the highest order of intellectuality.

Colombia is a republic, composed of nine departments corresponding to States. It has a constitution, ratified in 1886, similar to that



APPROXIMATE
RAILWAY MAP
OF
COLOMBIA

C.F.Z. CARACRISTI, C.E.

COLOMBIAN NATIVES.

ATLANTIC ENTRANCE, PANAMA CANAL.

of the United States, except in the provision that the departments shall be governed by the central government as in Switzerland. The executive power is vested in a president, a vice-president, and a *designado* who is second in succession after the president. The legislative branch consists of a house of representatives and a senate. The judiciary is composed of a supreme and lower courts.

Colombia occupies the very center of the western hemisphere, and its territory connects South and North America by the isthmus of Panama. It also holds a strategetic position of the greatest importance, and is the center of vast commerce. The country is very varied in climate, altitude, and productions. It has magnificent bays and harbors, navigable rivers, volcanoes and glaciers, high table lands and low lands, and produces almost every variety of flora known to botany. The area of the country is, according to its last boundary settlement with Venezuela and including its claims upon the Mosquito coast, over 600,000 sq. miles. The population is estimated at more than 4,000,000. Colombia is equal in size to New England, New York, New Jersey, Pennsylvania, Delaware, Maryland, Ohio, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, and Georgia.

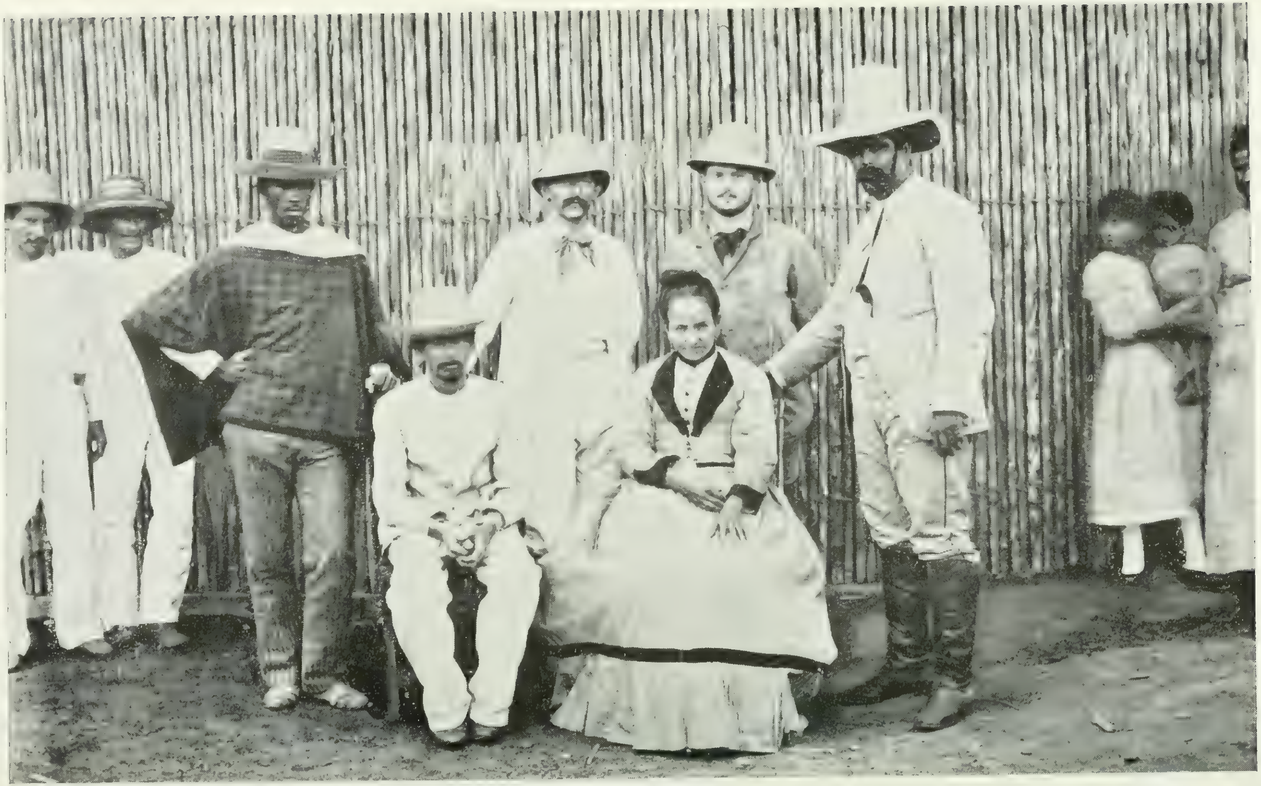
Colombia produces gold in large quantities, silver, copper, iron, coal, cocoa, coffee, cocoanuts, bananas, skins and hides, cattle, dyewoods, india rubber, cabinet woods, emeralds, cotton, and tobacco.

The most important mines so far discovered are the Sanncudo gold mines of Antioquia, the emerald mines of Muso (Boyaca), from which the government derives a large annual income, and the salt mines of Cundinamarca (Zipaquira), which are also a government monopoly. To these latter mines the government has also reserved the coal fields situated on public lands. The petroleum fields cover an area of over 1200 miles, containing constantly flowing oil springs.

The climate of Colombia varies from the oppressive heat of the equatorial regions to the cold of the Antarctic in the glaciers. The heat is not so marked as it is in the United States during the summer months, and near the coast during the day the thermometer stands at from 76° to 89° F., seldom rising above 95° even on the hottest days. The nights are cool, and the sanitary condition of the lower country is about the same as that of lower Louisiana. In the hills and mountain valleys the climate is a perpetual spring, where malarial diseases and pestilences are unknown. The isthmus of Panama is very unhealthful; rain falls more or less every day. The climate of the isthmus is about the same as that of the regions crossed by the proposed Nicaragua canal and the Tehuantepec railroad.

The routes of transportation are principally the rivers. The Magdalena is navigable from Barranquilla to the lower falls at Yegues, a distance of 600 miles, and above the falls by steamer and small boats 150 miles farther. The Sinu, Atrato, and Cauca are also im-

THE CULEBRA CUT, PANAMA CANAL.



MR. CARACRISTI IN AN INDIAN VILLAGE.

portant rivers. The Orinoco, Meta, and Amazon are navigable in Colombian territory, but they traverse a perfectly wild territory, and only the Meta is navigated by steamboats.

From the last accurate statistics that I have been able to compile, I find that the country's imports reached $15,361,402 during the year while exports during the same period amounted to $24,138,621 (Colombian currency). This shows a decline of more than $4,000,000 in imports, and an increase of more than $5,000,000 in exports, as compared with those of 1892. Evidently the decline in imports and increase in exports are due to abnormal conditions, the main ones being the high rates of exchange and the fact that the merchants are paying off in produce the old bills rather than purchasing new stock at ruinous prices. In 1892 the difference between American gold and Colombian paper was 81 per cent. in favor of gold, while to-day the premium on gold is 200 per cent.; that is, you can get three Colombian paper dollars for one gold dollar. With 81 per cent. premium on gold and goods sold on credit, there is a difference of $1.19 on every dollar of Colombian currency. For this reason the merchant has not been in a position to give new orders except for his actual current demand, but has been making heavy shipments of Colombian products to keep up payments. It must be added that

VILLAGE OF ARACATACA.

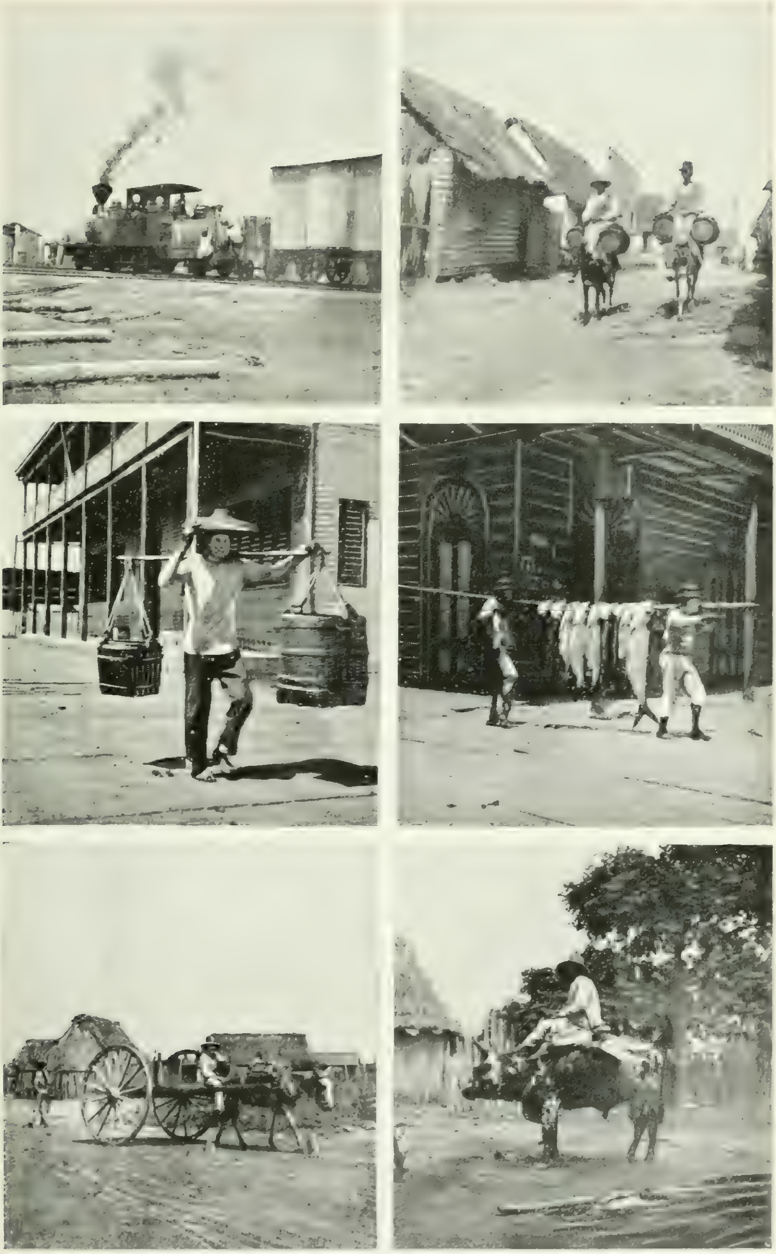
the Colombian merchant is honest and reliable, and that he will suffer almost any privation himself in order to meet his drafts and protect his commercial good name.

All of this commerce has been carried from the port of destination, from and to Colombia, by the use of 288 steamers and sailing ships, 41,000 *burros* (donkeys), 37 river steamboats, and 253½ miles of railroad. Twenty steamers touch regularly at Colombian ports each month. Of these six are under the United States flag, but they carry very little Colombian product, as they are used for the isthmus trade on the way to and from New York and San Francisco. Of course this trade, being only transient, is not accounted for in the statistics given here. Not one American steamer touches regularly at Colombian ports, except at Colon and Panama,—200 miles from the nearest continental Colombian port.

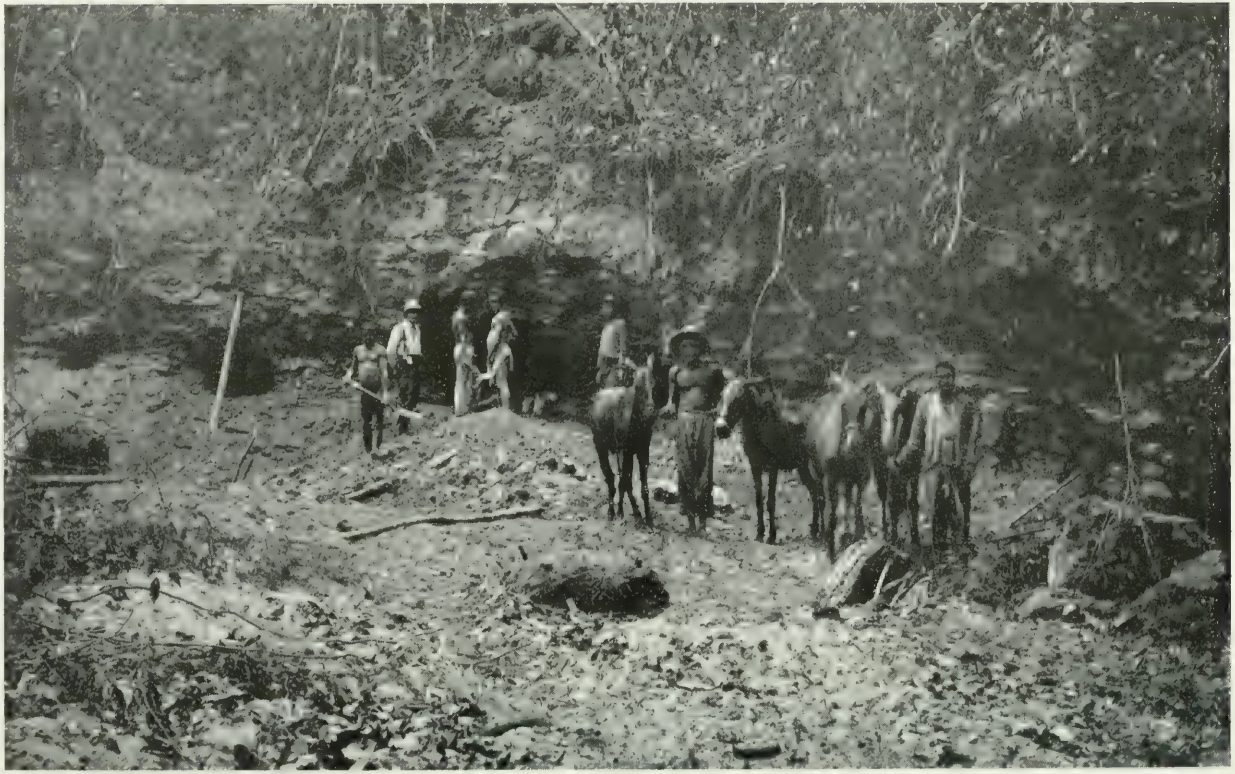
How should we account for this neglect on the part of our maritime interests? It is impossible to-day for an American passenger to reach either Cartagena, Barranquilla, or Santa Marta without sailing at least part of the way under a foreign flag. The Colombian trade is a paying trade; why should we not control it, in place of being satisfied with a little less than 11 per cent. of it?

As to railroads, the limited space at disposal prevents going into details here, and the reader must be referred to the careful and conservative review of the subject by Mr. Juan de la C. Posada ("The Railroad Development of Colombia"), in The Engineering Maga-

NATIVE HUT, NEAR TURBO, GULF OF DARIEN.



MODES OF TRANSPORTATION.



OPENING OF COAL MINES IN THE DARIEN.

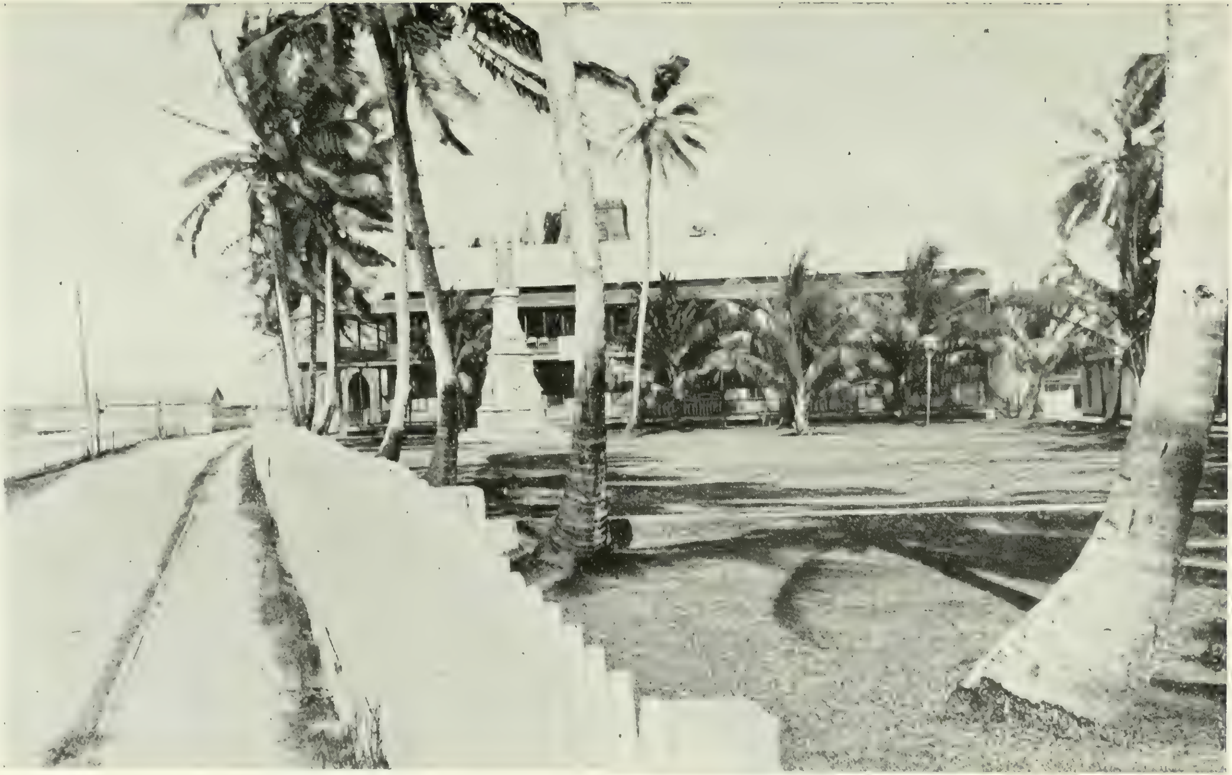
ZINE for August, 1893. Since the date of Mr. Posada's paper, the situation has, of course, somewhat changed; some progress has been made, and the outlook generally is promising.

Mineral development in Colombia is still in its most primitive condition, and in gold mining the methods used by the Cuna and Chibcha Indians are still resorted to. My two years of continuous labor in making the surveys, reports, and maps of the coal deposits of Colombia have just been crowned by the active development of the great coal measures of that region. Next to the Chilian nitrate beds, these coal deposits are the most valuable mineral of South America. To the navy and merchant marine of the world they are of great importance, and to the commerce of South America they are the foundation from which must rise an industrial future, while to the Panama and Nicaragua canals they are only next in importance to water. No coal mines are operated at present in South and Central America, except some poor lignite mines in Argentina, against which the Welsh coal easily competes. No less than 3,000,000 tons of coal are imported into South and Central America, the West Indies, and Mexico, the cost of which ranges from $8 to $20 per ton.

In the first place I busied myself with the examination of the coal measures of the isthmus of Panama near the boundaries of Costa Rica. Here I found only worthless lignite. This was near Chiriqui, the point which was examined by the United States navy officers, and which is remembered in connection with the "Thompson scandal,"

INDIAN SETTLEMENT, BAY OF SAN BLAS.

"CHRISTOPHER COLON," FRENCH QUARTER OF THE PANAMA CANAL, COLON.



"WASHINGTON CLUB," HEADQUARTERS PANAMA RAILROAD OFFICIALS, COLON.

COL. REEVES' HOUSE, COLON.

during Hayes's administration. From the Atlantic coast I crossed over the isthmus to Gulfo Dulce and Gulfito on the Pacific, where in the mountains I found some good coal, but did not examine it thoroughly. This was in a tertiary formation, and was much dislocated by convulsions which had occurred at some remote period. Analyses showed 34 to 41 per cent. fixed carbon, 1 to 2 per cent. sulphur, and 7 to 12 per cent. ash.

I next undertook the exploration of the coal found in the wilderness extending from Cabo de Tiburon and along the shores of the Gulf of Darien or Uraba and the many rivers that empty into it; and from this point I explored the whole of Colombia to the northern extremity of the Goajira peninsula,—a total distance of 600 miles. In the valley of the Atrato river the coal measures are well defined, and anthracite, bituminous, and cannel coal are found in great quantities. I paid but little attention to the coal of this valley, except to examine it as to form, etc., because I supposed that coal could be found much nearer the shores of the Caribbean sea or on the Gulf of Darien itself. Such proved to be the case.

On the Rio Veraquarando I found, on the upper waters, beds of semi-bituminous coal that would make the heart of any miner throb with joy. Here the coal is compact, of bright color, and low in sulphur; and more than sixty veins are encountered in a distance of ten miles. Coming northward, I again passed numberless coal veins, but these, at places, were somewhat decomposed on the surface. I had no way of mining; neither had I the time to do so; but what I did see on the surface convinced me that a large deposit of workable coal had been passed over.

On the banks of Rio Jobo, and also on those of Rio Punta de Piedra, about fifteen miles from the Rio Atrato on the eastern shores of the Gulf of Darien, the coal measures are again exposed, and, ascending the Rio Punta de Piedra about four miles, I found excellent beds of good, workable anthracite. Analysis gave 77.52 per cent. fixed carbon. The anthracite beds range from 3 to 12 ft. in thickness. The climate, a few miles above the exposed veins, is excellent.

After crossing many rivers and a series of *cienagas* (swamps), I arrived at the Rios San Juan, Jobo, and Arboletes, where I found a large number of beds of excellent bituminous coal. Three or four miles from the coast on the Rio Jobo I found one bed of bituminous coal of excellent quality, nearly 15 ft. thick. Next I examined the coal on the Sinu river and a vast deposit of cannel near the bay of Cispata. In these regions there are over eighty veins of cannel and semi-bituminous coal of the best quality. Analyses of this coal show it to be of high commercial value. From this point the measures were followed to the Sierra Nevada de Santa Marta, where cannel is found in large quantities.

Now that the world's petroleum supply has reached an alarming

COUNT DE LESSEPS' HOUSE, COLON.

MARKET ON THE MAGDALENA RIVER, BARRANQUILLA.

point of under-production as compared to the future visible demand, it may be interesting to learn that Colombia contains some of the finest oil fields ever discovered, and that, although there has been no publicity as to the working of these wonderful fields, yet it is a fact that they are to-day being developed with a view of eventually controlling the South and Central American markets. How far this work will progress, and what effect the Colombian supply will have on the oil markets of the world, remains to be seen.

My explorations began on the Rio Atrato and extended into the hills that face the eastern shores of the Gulf of Uraba. Over nearly all the territory I found more or less oil, but the best specimens were those obtained near anthracite and semi-anthracite coal. Much oil is found on the Caribbean near the port of Arboletes, the fields running from there in a northeasterly direction to the Magdalena river. From the first point where I found the oil, to Barranquilla, on the Magdalena, is a distance of more than 300 miles by a circuitous route. In connection with the oil, I also found a number of natural gas vents, the most important of which are near Turbaco, southwest of Cartagena, the capital of Bolivar. The strata carrying the petroleum are generally horizontal, and where they have a dip it is only about 12°. Most of the oil is high in naphtha.

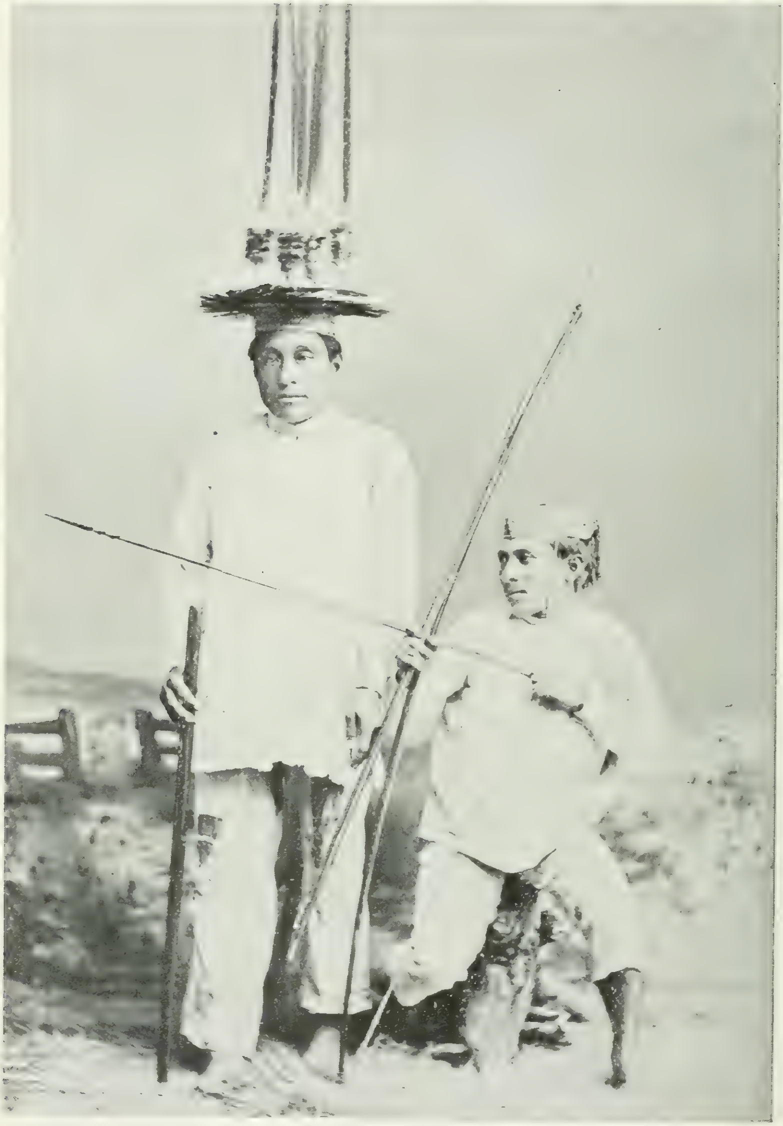
Large deposits of asphaltum and ozocerite are found in the neighborhood of the oil, which in quantity and quality are equal to those of Trinidad. Tests made of Colombian asphaltum proved its practical value.

The valleys of Colombia abound in fossil resin, used often as amber. This is found in irregular pieces, from the size of a pea to that of a barrel. For the manufacture of shellac varnish the material is of the best quality, but thus far no practical use has been made of the product. An interesting feature of this product is that it is pine resin, but found in localities where it would be impossible for pines to grow now, owing to the great heat. From this it must be inferred that the resin was deposited there at a time extremely remote, when pines could grow in what is now an ultra-tropical region.

According to Rectrepo, nearly $1,000,000,000 worth of gold has been produced in Colombia since the time of the conquest. The present yearly shipments of gold and silver amount to about $1,000,000, mostly from the mines of Antioquia, Tolima, Cauca, and Santander. My own investigation of the subject has assured me that the greatest possible opportunity is offered in the gold, silver, and platinum fields of Colombia. During my explorations I have crossed hundreds of miles of alluvial deposits and innumerable veins of gold-bearing quartz. Many of these deposits would be extremely valuable in the hands of enterprising owners. As it is, they are almost unknown, while thousands of miners all over the world are idle. No better opportunity is available to young men of adventurous spirit, with a little money, than in the gold and silver mines of Colombia.

Large quantities of quicksilver are found in the lime formation of the central range of the Andes. There the deposits are of cinnabar;

PLAZA, BARRANQUILLA.



KING OF THE SAN BLAS INDIANS, SACEDI.

BOGOTA—PROCESSION DEL CORPUS.

INTERIOR OF GENERAL POST OFFICE, BOGOTA.

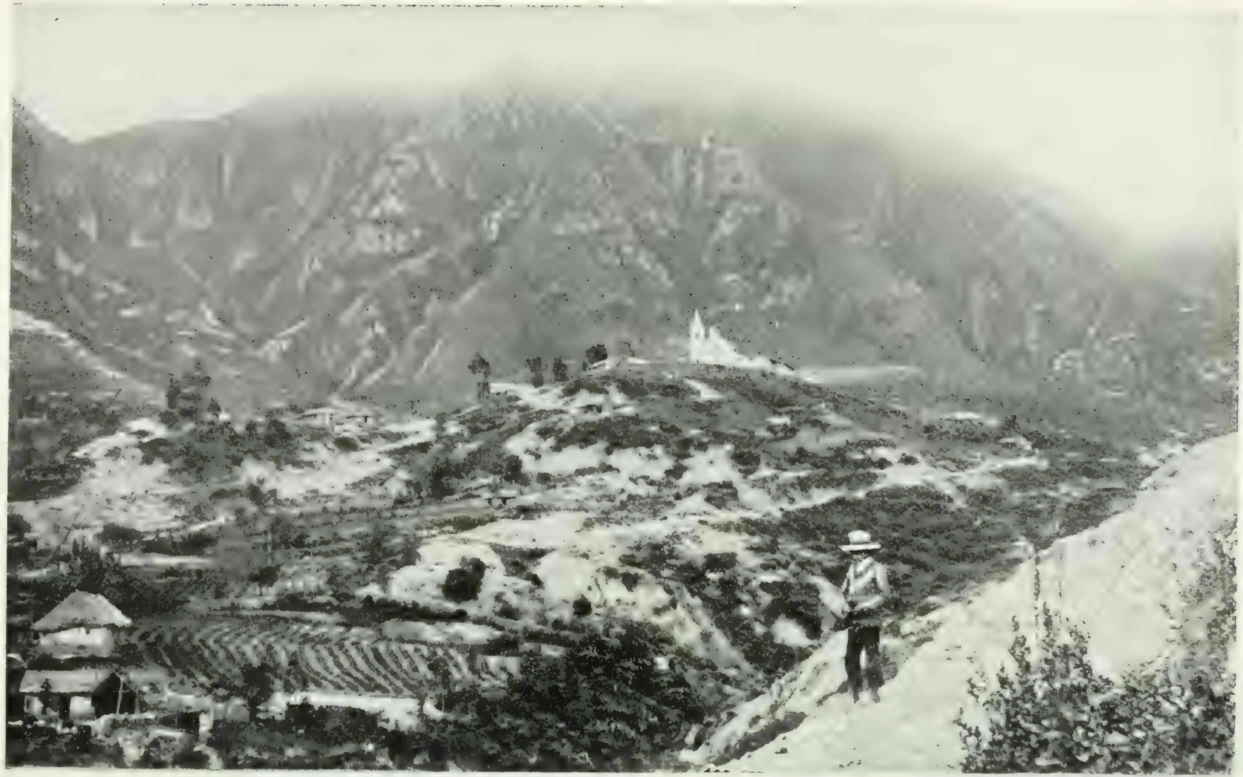
while on the Atlantic coast native quicksilver is often found in a porous sandstone. This product, too, might and should be made the basis of serious and profitable operation.

Colombia abounds in the rarest varieties of marble and onyx. The white statuary marble of La Cienaga in the department of Magdalena has proved itself equal to that of Paros and Italy ; and as the deposit, rising 1000 ft. above the sea level, is situated only two miles from the Caribbean, its commercial value should be seen at once, especially when we remember that the stone in the crude is worth $9 per cu ft. The green, red, black, purple, and variegated marbles of the interior are some of the most beautiful I have ever seen. The onyx deposits, too, are extensive, and will be valuable whenever mediums of communication are established from the interior to the coast.

Gypsum beds extend along the coast for several hundred miles, and are of excellent quality, but so far no work has been done on them. The stratum is some 10 ft. thick and in many places translucent. This material, which is largely used in the manufacture of plaster of Paris and fertilizers, could be mined at about 50 cents per ton, and the freight to this country should be only an additional $1.75 per ton.

Phosphate of lime is found in large quantities on the Goajiran peninsula and at other places along the coast. These deposits in places

"LA PRADERA," THE GREAT IRON WORKS NEAR BOGOTA.



VIEW OF COUNTRY NEAR BOGOTA, 9500 FT. ABOVE THE OCEAN.

CAPITOL SQUARE, BOGOTA, COLOMBIA.

TAQUENDAMA FALL, NEAR BOGOTA—A PLUNGE OF 700 FEET. INCLUDING THE RAPIDS ABOVE, ABOUT 95,000 H. P. AVAILABLE FOR ELECTRIC TRANSMISSION.

are very large, but, owing to the uncivilized condition and warlike proclivities of the Indians, were unknown until my exploration of the region.

Large quantities of copper ore are found back of Santa Marta and along the eastern range of the Andes. In the Sierra Nevada there are large veins of copper-bearing quartz, carrying a good percentage of silver and some gold. Why they have not been worked is a matter that I cannot understand, as they were known to the French through the able report of M. Fleury, who examined them some ten years ago.

Iron ore is found in large quantities in Colombia, and embraces all of the known varieties. Red and brown hematite are the most common, but good bessemer magnetite is found in many localities, especially in the Santa Marta mountains, where coal and limestone for flux are found in abundance. This is a healthy locality, where man can select his own most suitable climate, owing to the fact that from the low lands a series of table lands rise to a height of over 15,000 ft. above the sea level. At La Pradera in the department of Condinamarca the enterprising General Bariga has started and is operating an iron furnace and general iron works, which have cost over $1,000,000. The work done there is of the best quality and workmanship. The castings are perfect. The Colombian artisan is generally able and industrious in the mountain regions, where the heat is not oppressive, and General Bariga has now trained Colombians to do all his work.

Colombia abounds in large deposits of manganese ore, and at one place alone, near Puerto Bello, over 2,000,000 tons of the mineral has been measured up by Mr. Schablas, the superintendent of the Caribbean Mining Company, of Baltimore. This company has just completed a 14-mile railroad, connecting Vientos Frios with the mines. I learn that shipments of the ore are to be made at once.

Colombia will produce all of the known agricultural staples. All that is necessary is to rise into the mountains for a colder climate. Bananas, cacao, cocoanuts, coffee, wheat, rice, oats, potatoes, and, in fact, almost anything can be grown by choosing the proper altitude. Some of the banana, cocoanut, and coffee plantations are now actually paying an interest of from 40 to 85 per cent. on the original investment. No country affords a better opportunity to the ranchman or farmer willing and able to work than Colombia. What Colombia needs is a fresh start,—new blood and Anglo-Saxon energy and progress combined with modern methods and machinery; if she gets it, what is now a wilderness will become in a few years a smiling garden of wealth, prosperity, and industrial and social harmony.

THE MAGNETIC SEPARATION OF IRON-ORES.

By Clinton M. Ball.

IN many localities throughout the world magnetic iron-ore is found in large bodies, and in convenient proximity to other resources required for its conversion into commercial iron and steel. Many of these would have great commercial value if they were suitable for direct use in the operation of steel-making, on account of their nearness to the principal points of consumption. But most of these ores are associated with substances capable of entering into deleterious combinations with iron or its oxids, and thus are unfit for use in the production of the higher grades of finished metal. It is only since the development of the bessemer process that the art of the chemist has come to the aid of the manufacturer in the investigation of the causes and effects of the presence of these pernicious elements, the most common of which are phosphorus and sulphur, during the process of reduction. Generally, though not always, these elements are found existing in non-magnetic compounds,—a circumstance which has led to the expenditure of much time, money, and ingenuity in unsuccessful attempts to effectually separate the magnetic oxid of iron from crushed ore, and from sands, in which latter it occurs in great abundance in many parts of the world.

The enormous increase in annual consumption which has resulted from the cheapening of steel through improved processes of manufacture is forcing steel-makers to inquire whence are to be obtained the future supplies of bessemer ore to meet the ever-increasing demands of the trade,—a question only partially answered by the remarkable developments in recent years of the ore-ranges of the Lake Superior district. The future prosperity of American steel manufacture must depend largely upon the ability of our manufacturers to meet the world's lowest prices, and this in turn is dependent upon the certainty of an adequate supply of the raw material at prices at least but little in advance of those ruling at present.

The critical study of the conditions of economical production inevitably resulting from the industrial depression of recent years has led, among advanced furnace-managers, to a keen appreciation of the important advantages attending the use of the richer ores, in the way of improved quality, increased output, economy of fuel, and general reduction in cost per ton of product. This, in turn, has directed attention to the peculiar advantages possessed by properly-prepared magnetic concentrates, consisting, as they do, not alone in the low percentage of deleterious impurities, but in what is no less important in steel-manufacture,—absolute uniformity in grade. Both the theoretical and practical importance of magnetic concentration as a factor in steel manufacture has been fully determined, and is now freely conceded; it only remains to ascertain to what extent the process is commercially feasible under existing competitive conditions.

The history of the art of magnetic concentration is largely one of sunken capital, abortive experiment, and unrealized expectations, and in the category of helpless failures must be counted some of the most ambitious and expensive undertakings of recent years. Without attempting to dwell upon these, it will be sufficient, in the present paper, to point out the road to successful practice, and to make brief reference to what has been actually accomplished.

In attacking the problem of ore-separation from its practical side, the first consideration must be that of the maximum possible efficiency of the method of separation proposed. In earlier days the experimenter, fascinated by the mysterious rush of ferruginous substances towards magnetic poles, hastily concluded that a powerful magnet,—and of course the more powerful the better,—combined with any crude apparatus for moving the ore into and the magnetic constituents out of its sphere of attraction, would fulfil every requirement of the problem. It was, moreover, assumed, with a confidence born of inexperience, that, in a finely-divided mixture of magnetic ore and non-magnetic gangue passing in a stream through a magnetic field, the former might be cleanly separated from the latter into "heads" of substantially pure magnetic oxid and "tails" of barren gangue, by a simple two-part division. Not until the history of hundreds of failures had been written into the archives of the patent-offices of America and Europe, did it, apparently, occur to any one that any virtue might be found in a specific and rational distribution of the lines of magnetic force with reference to the moving masses of pulverized ore; and even at the present time many persons representing large interests in iron-mining and metallurgical operations are apparently wedded to, and unable to see beyond, these fundamental fallacies of inexperience, and so, from a disastrous experience of unsuccess, rashly jump to the conclusion that magnetic separation, as a useful art, can have no existence.

In determining the efficiency of a proposed method of ore-separation, representative samples, produced under conditions of actual commercial performance, of the crude ore, the concentrate, and the tailings, should be obtained, and their respective percentages of magnetic and non-magnetic constituents accurately ascertained. The efficiency and practical value of any system may then be ascertained by the application of simple formulæ. In order to satisfactorily meet the conditions of transportation and use, a concentrate should have the coarsest possible granulation combined with the highest attainable purity, the respective percentages of sulphur and phosphorus, being brought at the same time, if possible, within bessemer limits. Chemically pure magnetic oxid corresponds to the formula $Fe_3 O_4$, or 72.42 per cent. of iron and 27.58 per cent. of oxygen. Crystals of this oxid obtained from different mines will vary widely in size, but those from each individual mine are likely to present a general uniformity in character and dimensions. The general average of such ores may be taken to consist of about equal parts of magnetite and gangue. In the concentration of such ores, if the percentage of magnetite be raised to 90, with 4.5 per cent. of magnetite left in the tailings (corresponding to 65.18 per cent. of iron in the concentrate and 3.26 per cent. of iron in the tailings), the result may be looked upon as satisfactory, inasmuch as this standard in the concentrate will usually reduce the proportion of phosphorus and sulphur within the required limit.

In this case it requires 1.879 crude units to make 1 concentrate unit, and 95.79 per cent. of the magnetite in the crude ore is saved in the concentrate, while 4.21 per cent. is lost in the tailings; the actual efficiency of the operation of separation will, therefore, reach nearly 96 per cent.

It might seem at first sight as if such a result as that above indicated might be realized by any well-constructed separator, irrespective of its particular type, provided sufficient magnetic force were present to prevent the escape of magnetic particles into the tailings. But the result in reality involves a more complex series of operations than would at first appear. The concentrate ought to be as coarse as possible, not only for technical reasons already stated, but because of the enhanced cost entailed by unnecessarily fine crushing,—a cost which in some instances might easily make all the difference between commercial success and commercial failure. Moreover, a sound theory of ore-separation dictates that in the initial stages of the process the operation of crushing should be carried only just far enough to cause the product to correspond in the average dimensions of its fragments with those of the pure magnetite. A mass of ore in this condition will contain pieces of pure magnetite, others of pure gangue, and still others of a complex character,—part magnetite and part gangue,—the latter constituting perhaps 10 per cent. of the whole. It is obviously desirable that, when in this stage, the three grades of material should be separated before going further, inasmuch as the pure magnetite would require no further treatment, and the pure gangue might be rejected as tailings, thus at once completing the treatment of at least nine-tenths of the whole mass. On the other hand, the composite portion of the material, if permitted to pass into the concentrate, would carry all its impurities with it, and at the same time lower the percentage of iron in the product, but, if thrown away with the gangue, would involve an inadmissible waste of valuable material. This intermediate portion, therefore, should be re-crushed to a fineness sufficient to liberate substantially all the magnetite from its adherent gangue, and afterwards re-separated, after which the respective products of re-separation may be added to the concentrate and tailings of the preliminary separation. It will be obvious that the "middlings" resulting from the preliminary separation must closely correspond in grade to the average of the crude ore, and that but a comparatively trifling expense need be involved in the reduction and re-separation of so small a proportion of the original mass. The great importance of this three-part method of treatment may be demonstrated by an analysis, which need not be given here, the results of which show that, if the middlings should be added to the concentrate, instead of being re-crushed and re-separated, the product would consist of 57.9 per cent. of concentrate and 42.1 per cent. of tailings; while, on the other hand, if the middlings should be thrown out, the product would consist of 47.9 per cent. of concentrate and 52.1 per cent. of tailings.

Even the apparently small difference between two concentrates, one containing 60 per cent. and the other 65 per cent. of iron, is really of very great importance, for, while the latter would contain only 10 lbs. of gangue in each 100 of concentrate, the latter would contain nearly 17 lbs., and would usually carry with it such an amount of sulphur and phosphorus as to render it wholly useless for bessemer requirements. Moreover, experience has demonstrated that a difference of no more than five units of iron in each hundred, in the charge of a blast furnace, may make a difference of as much as 20 per cent. in its effective output.

In view of the above considerations, it is not difficult to understand the reasons underlying the disastrous commercial results of attempts at two-part separation by magnetism, as well as by water-jigging and other analogous methods, or why the successful practice of the art has so long been compelled to await the advent of a separator constructed in accordance with scientific principles.

It will readily be understood, after what has been said, that the successful carrying-out of the three-part process of separation above outlined must require an apparatus capable of working with great precision. Such an apparatus must discriminate accurately between the different grades of material, must make a clean selection of magnetic from non-magnetic material, and, among particles of mixed material of varying degree of purity and magnetic susceptibility, must differentiate the middlings from the pure magnetite. All this, however, has been successfully accomplished by some of the recent machines.

It is unnecessary in an article like this to enter into a minute technical description of the construction and mode of operation of such an apparatus. For the present purpose it is sufficient to say that the machine comprises, first, a stationary range of magnetic poles, alternately of unlike polarity in the direction of the ore-travel, underneath which the drums, enclosing the two groups into which the range of poles is divided, serve as rotating carriers of the granulated ore, the ferruginous particles being sustained upon the under-surface of the drums by magnetic attraction ; second, of means for applying a strong counter-current of air to the moving mass of ore while passing through the machine ; and, third, a differential speed of rotation of the respective drums, assisted by a relative adjustment of the magnetic strength of the two groups of poles for the purpose of differentiating the ore under treatment into the grades which have been referred to. In this type of machine provision was for the first time made for the coöperative and interdependent functions which render the three-part process of separation a commercial possibility. The most characteristic and essential feature in the mode of operation of such a separator consists in the tumbling or shaking of the magnetic fragments while suspended upon the under-side of the rotating drums, which results from their conveyance through a series of successive magnetic fields of alternating polarity. The multitudinous conceptions embodied in the machines of prior inventors, however varied in other particulars, were alike in this,—that they one and all presented a field of unchanging polarity to the stream of moving ore in the direction of its motion ; hence there could be no possibility of further separation after the mass had once attached itself to the carrier. It will be readily apparent that such machines were fundamentally defective in principle. On the other hand, when a mass of granulated ore consisting of mingled magnetite and gangue is brought within the influence of two unlike magnetic poles, the particles form themselves into chains or loops, extending coincidently with the lines of magnetic force, from one pole to the other. The impounded fragments of gangue can be extricated from these loops only by breaking up their formation, while at the same time an adequate force is acting to remove the particles as soon as they are released. Such a breaking up of the loops is effected by causing them to pass into a field of reverse polarity, and meanwhile centrifugal force, gravity, and the counter-current of air are acting conjunctively to withdraw from the magnetic field the non-magnetic particles of gangue. In practice it has been found that the mere adjustment of the attractive force of the second group of magnetic poles is quite sufficient to ensure the complete separation of the middlings from the pure magnetite. This may be done, too, with any desired degree of precision: for example, particles consisting of five-eighths magnetite and three-eighths gangue may be retained in the concentrate, while particles containing a larger proportion of gangue will pass into the middlings, and so of any other proportion required. The importance of this feature in practical work need not be dwelt upon.

Fabulous sums have been and are now being wasted in mining, transporting, and smelting slag-making rock. A modern furnace costs far more than a separating plant of the type which has been described, not only in the original outlay for construction, but in expense of operation, while it cannot handle or dispose of anything like an equal quantity of raw material. The gangue or slag-producing substance, if permitted to go into the stack, must be transported, handled, melted, fluxed, and otherwise disposed of, at no inconsiderable expense, while, if carried direct to the separator, this useless rubbish is left on the tailings dump at the mine, and once for all got rid of at a comparatively trifling cost. A 50 per cent. ore has, until recent times, been regarded as a good grade of crude. It is a good-sized furnace that, working upon such an ore, can make an output of 100 tons of pig per day, and the expense of its operation is very great. A single separator of the type indicated will easily handle from 16 to 25 tons per hour of crude ore, and produce from 8 to 16 tons of 65 per cent. concentrate, the amount depending upon its granular condition and its richness. This quantity of concentrate would enable such a furnace to increase its output from 100 to 165 tons per day, so that one furnace and a separator would actually have nearly the productive capacity of two furnaces of the same size without the separator, while the comparative cost, both of construction and of operation, would be immensely in favor of the former organization.

Uniformity in the grade of the concentrate is the necessary result of the normal operation of the separator, and this results in uniformity of quality in the product of the furnace,—a matter of the utmost importance in steel-making, for, while it is true that large supplies of rich ores may be obtained from Lake Superior mines and other sources, these do not run uniform, either in grade or purity. In fact, considerable variation in percentages of objectionable impurities are not infrequently found in successive lots from the same mine. On the other hand, a magnetic concentrate from any given mine will always run practically uniform, however great the variations in the crude ore from which it is extracted, while its richness will fully equal that of the very best of native ores. The separator, therefore, must prove an invaluable auxiliary in aiding the manufacture of better and cheaper iron.

Since the year 1888 many plants for crushing and separating ore have been projected, and a considerable number have been erected and put in actual operation. Among the first plants in point of time, and absolutely first in technical and commercial success of operation, was that of the Magnetic Iron Ore Company at Benson Mines (formerly known as Little River), St. Lawrence County, N. Y. At that place, for the first time in the history of the art, magnetic separation was successfully prosecuted on a commercial scale, in the treatment of a low-grade, non-bessemer ore, to eliminate deleterious impurities and render it fit for steel-making. Prior to the date mentioned, the Magnetic Iron Ore Company had expended a large sum in building a railroad to Jayville, N. Y., developing the mines at that place and securing other property at Little River, before it was determined that natural ore of good quality was not to be found in paying quantities. The only way of saving this large investment was the establishment of a large concentrating plant at Little River now Benson Mines—and the extension of the railroad to that point, near which exists one of the largest deposits of low-grade magnetite known in the United States. The ore has a dense, fine-grained structure, averaging about 45.5 per cent. of magnetite and 32.95 per cent. of metallic iron; and the crystals of magnetite, which approximate 1-16″ in average dimensions, are found associated with small crystals of apatite and pyrites. These peculiar characteristics of the crude ore render the process of milling and concentration, both from a technical and commercial point of view, a most difficult one. In order to be marketable, the ore must all be concentrated, while, to reduce the sulphur and phosphorus to steel-making requirements, the iron must be raised in the concentrate to run about 64 per cent., or to carry say 88.5 per cent. of magnetite and not more than 11.5 per cent. of gangue, and this must be done without involving an uncommercial loss of iron in the tailings. The problem was, however, satisfactorily solved by the application of the principles laid down in the present paper, the machinery having been put in successful operation in 1889. The plant, after having been greatly enlarged the following year, was maintained in nearly continuous operation until the great depression in the iron industry began in the summer of 1893. When in full operation, the works have a capacity of 1000 tons of crude ore per day of 24 hours, yielding about 500 tons of concentrate, the average character of the product being as follows:

	Magnetite.	Metallic iron.	Sulphur.	Phosphorus.
Crude ore,	45.5 per cent.	32.95 per cent.	1.00 per cent.	0.15 per cent.
Concentrate,	88.5 "	64.09 "	0.21 "	0.032 "
Tailings,	4.0 "	2.00 "		

Thus 95.53 per cent. of the magnetite in the crude ore is saved in the concentrate, and 4.47 per cent. lost in tailings, demonstrating the possibility of the conversion of a low-grade non-bessemer into a high-grade bessemer ore, and showing an efficiency of no less than 95.53 per cent. in commercial operation on a large scale.

Following closely upon the operations at Benson mines, a considerable revival of interest in the subject of magnetic separation was developed, and a number of plants were projected and erected in different places. At Mineville, N. Y., a series of elaborate and costly experiments and tests of separators of various types was carried out during the years 1889–92, which ultimately resulted in the adoption of the process above described. A similar result ultimately followed an attempt to work the two-part process at Bechtelsville, Pa., in 1889, which was definitely abandoned as unsuccessful, and was succeeded by the present profitable plant at Rittenhouse Gap. The Tennessee Coal, Iron, and Railroad Company is at the present time prosecuting at Bessemer, Ala., a series of most important tests, looking to the concentration of red, fossiliferous ore by first roasting to render the ore magnetic, and then concentrating with the magnetic separator; the outcome will be watched with great interest by Southern iron-masters.

The magnetites of the Champlain-Adirondack region yield exceptionally favorable results under this process, by reason of the facility with which they may be crushed and prepared for separation, and the purity and unusually coarse grain of the product. A typical example may be cited from the results of the treatment of ore from the new bed of Witherbee, Sherman & Co., of Mineville, N. Y., the preliminary crushing being carried to 1-6″.

	Magnetite.	Metallic iron.	Phosphorus.
Crude ore,	66. per cent.	47.8 per cent.	0.07 per cent.
Concentrate,	94. "	68.075 "	0.0123 "
Tailings,	8. "	5.79 "	

In this case 96.03 per cent. of magnetite in crude is saved in the concentrate, and only 3.97 per cent. is lost in tailings.

The increase in furnace capacity and improvement in quality of product resulting from the use of richer raw-material in the form of uniform high-grade concentrate is scarcely less important to the manufacturers of foundry pig-iron than to steel-makers, and, since results corresponding to those which have been cited may be obtained wherever similar ores exist, we may expect that, with the advent of increasing activity in the iron and steel industry, separated magnetic ore will ultimately fill a most important place in the supply of raw material for this most important industry.

PRODUCTION UP TO THE POWER LIMIT.

By Horace L. Arnold.

SUPPOSING a machine shop to have the best plant procurable, which means a large investment in lathes, planers, slotting, shaping, and milling machines, and quite commonly, now that the day of the general machine shop is passing, and almost every establishment, large or small, has its special line of production, a considerable number of machines especially adapted to the shop's individual requirements ; supposing also, that this plant of carefully-constructed machines is put into the hands of a superintendent who fully understands that he, and he alone, must make the concern a commercial success,—under these conditions what should be the policy of the superintendent regarding the use of his fine and costly machine tools ?

Shall he regard them with that pride, and affection even, which a really fine machine tool inspires in the appreciative mechanic, and, so regarding them, shall he use them carefully, taxing their productive powers well within the endurance limit, and having their preservation and long life always in mind ? Or shall he regard them as merely a means to an end, to be used to their utmost power limit, regardless of the effect upon their nicely-fitted organizations ?

At first sight it would seem that the most successful machine-shop superintendent must assuredly be the one most careful to have his machine tools, which perform nearly all of his work, in the most perfect order, so that every operation should be made with a certainty of accurate results. It is perfectly well known that machines have their limit of endurance ; the front journal of a lathe spindle, for instance, may be run for many years by a careful lathesman with so little detriment as to remain during all that time in nearly as perfect condition as when it left its maker's hands. Or this front lathe-spindle journal may be overloaded with heavy weights on the face plate, or heavy cuts on light pieces of face-plate work, so that the boxes and spindle both show wear in a very short time. A lathe spindle which once shows faulty running is very seldom put exactly right again ; it may be helped, but it is not often made as good as it was at first. Shall the superintendent of the fine equipment permit men running tools to drive them hard, and so risk the destruction of their accuracy of fitting ?

On the other hand, regarding his splendid array of machines as mere aids to a desired result, shall he seek the speedy accomplishment of that result, regardless of the effect of haste on the instruments used ? Shall every machine, every lathe, every planer, every shaper and driller and milling machine, be driven up to the limit of the belt pull? Shall every tap, broach, and reamer be urged to the nearest possible approach to breaking strain, if the muscle of the workman can force it so far?

Certainly the commercially successful machine-shop superintendent can in no case permit obvious abuse of his machine tools; for example, he could not permit a planer table to be used as an anvil for straightening heavy pieces, nor would he allow the use of a sledge in adjusting face-plate work on a small lathe; such practices would destroy his plant at once, and could not be tolerated. But it is very evident that, when the question takes a slightly differing degree, there may be two sides to it.

Suppose a shafting lathe can finish 200 ft. of shafting a day for 20 years before it needs a rebuild; suppose, also, that it has power enough to turn 400 ft. of shafting per day, if urged to its utmost; in this case, if the lathe would run 10 years on the 400-ft. daily production, it would give the same total production as if its life had been prolonged to 20 years by easy usage.

But, when we consider the commercial side of this shafting lathe performance, it is at once seen that, while the total output of work is the same in each case, the work done by the carefully-used and long-lived tool has cost twice as much in wages, twice as much in insurance, floor-room, and all fixed charges, as the lathe driven to the limit, and worn out in half the time. Hence it is clear that in all cases the careful use of any plant must make the product more costly than if the plant were urged to its full capacity; and it is evidently not absurd to say that machine tools may be used with such care for their preservation that they fail wholly in the original object of their creation: they are never money-makers: their production is never great enough to warrant their existence; and the shop carefully managed to this unprofitable extent must go out of business, and cease to exist, simply and solely because of the anxiety of its superintendent or manager to prolong the life of its machine tools.

Machine tools are invariably, or almost invariably, used in conjunction with the labor of workmen. There are some automatic machine tools in use, as, for instance, some screw machines now in operation at Windsor Locks, in Connecticut, which are run by water power, and can be, and are, safely locked up and left to themselves for a week's run without attendance of any kind. But, speaking generally, machine tools are used with workmen, and with workmen who are paid more than medium wage.

Suppose a small lathe cost $500, and lasts 10 years. With money at 5 per cent. the yearly cost of this tool is $75 for the bare machine itself. It may occupy a floor-space of greatly varying rent value: perhaps as little as $15 yearly. The labor figures are much larger; the lathe hand may be paid $1.50 per day, or $2.00, or even $3.00. If his pay is $2.00 per day, it is $600 for 300 days, or a year of working time; then for 10 years of lathe work as specified the shop pays $500 for the lathe, $250 interest, and $150 rent, and perhaps another $100 or so for other fixed charges, or say $1000 for the 10 years' life of the $500 lathe. But in the same time the shop has paid out $6000, or six times the machine-tool outlay, for labor to operate the tool. The total expense for the 10 years of assumed lathe life and use is $7000, of which only $1000 is chargable to the machine-tool account. Suppose now that, by driving this same lathe to the utmost limit of its belt pull, it had been forced to double its output, and had lived for only 5 years of service. This gives the same total product as before, at a machine-tool, rent, and interest cost of only $750, and a labor cost of $3000, making a total of only $3750 paid for the work as against $7000 paid for the work of the same tool with double the life; hence the profit on the output might be very great if the machine tool were destroyed quickly, as against nothing at all if the lathe were worked at an easy rate.

This simple example makes it very clear that accuracy, finish, close fitting, and easy handling,—the distinguishing points of our American machine-tool production,—are not enough in themselves to insure the commercial success of the users of such tools. To these most desirable American features the commercially successful machine tool must add a great metal-removing capacity; the greater the better, unreservedly. Hence the constant additions to weights of our machine tools for equal capacities, and the equally steady increase in the driving power given to tools of nominally the same sizes. Hence, too, good practice clearly demands the prompt retirement of such machine tools as are incapable of comparatively large production. They may be still in good condition, of respectable ancestry, stamped with names of which every American mechanic must always be proud, names of machine-tool builders who were leaders in their day; and yet these prides of the past should not be kept in use, and cannot be kept in use by any concern intelligently seeking commercial success.

Shall the superintendent, then, discard at once all reverence and sympathy for his machinery, and drive every tool in his charge to its utmost limit of production as fixed by the width and speed of its driving belt?

Shall he regard a planer, for instance, as an instrument by which a certain number of cubic inches of metal may be cut into chips, and make it cut that amount of metal and fit itself for the scrap heap in the shortest possible time? Assuredly yes, if the use of that planer is to make money.

The cost of labor is so very great in proportion to machine-tool cost in all machine-shop operations that the life of the machine tool is not an element to be considered at all. With the larger and more expensive class of lathes, planers, and machine tools generally, there is no danger at all of injury through over-driving. They are too large and have resisting surfaces of too great an extent to be injured by any effort of the workman's strength, or by the use of their own driving power along intended lines. They may possibly suffer through accident, very seldom indeed through over-driving.

The visitor who enters the Baldwin locomotive shops for the first time is at once impressed by the lavish supply of cranes in every department of those vast works. His next impression, if he be familiar with machine-shop interiors, is one of surprise at the remarkable diligence of the workmen; finally, as he becomes sufficiently familiar with his surroundings to notice details, he observes that very unusually large cuts are being taken in all places where there is a large cut of stock to be removed, and, when he turns his attention to details performed by hand, he sees the same extraordinary effect, gained in many cases by what would be considered in many shops a very uneconomical urging of the hand tools.

The shops themselves, as is well known, cover several squares in the vicinity of Fifteenth and Buttonwood streets in Philadelphia. They can use five thousand five hundred men, are the largest in the world in their line, and pay the highest wage given anywhere in the world to men in similar lines of employment; and the visitor familiar with the metal-working arts is very speedily led to the conclusion that, notwithstanding this high wage, the work is done very cheaply indeed, and in many cases at incredibly low prices.

Thus a pair of locomotive side frames 20 ft. long × 27 in. greatest width × 4 in. thick are surfaced on both sides accurately to thickness, and the straight side squared, in 8 hours. The price paid for this planing seems wonderfully low, as indeed it is; not only low, but so incredibly small as to make such a performance of deep interest to every superintendent and shop-owner.

The planer used for side frames in the Baldwin shops is a Sellers, with a very low housing and small cross rail in proportion to the table width and length. The cross rail is fitted with two saddles and tool posts; the drive is, of course, the well-known Sellers rack and screw, and handles very easily and promptly; this ready handling is an essential feature in the operation, as the machine reversing gear is not much used in planing side frames. The frames are put down with the horns of both heads towards the workman, and the two are placed so that the ends are even square across the table; the two tools in the two tool posts are set so that one just touches the far straight top line of each frame ; then the tools are moved together over to the front side of the jobs, next to the workman, who starts the cut on the extreme ends of the horns of the driving box seat nearest to him, with ¼″ feed for the first roughing cut ; with the tools and frames set as described, whatever is done to the first frame is also done to the second one, and so the man has only one frame to watch as he sits in front and ships by hand, and ships very closely indeed, losing only a very small table travel on each end of each cut. The forgings are not at all close, there being as much as $\frac{7}{16}$ or ½″ to carve off in some places, thus making quite a stiff cut, ¼″ × ½″, on the two frames taken together = ½″ × ½″ section of metal removed at once. The planer is amply powered, however, and does not notice the work at all. The finishing cut with the flat nose tool is made with ¾″ feed, and does not take long. The roughing tool is what they term the "Oyster Shell" tool, with a rounded nose, and has an average of 12 or 15 degrees slope both ways, the point leading the top of the cutting edge. The side and bottom tool clearance angles are very small, perhaps not more than 3 degrees. Every hand grinds his own tools, and hence the cleavage and clearance angles vary considerably; but the "Oyster Shell" form, as it is called,—a name not used elsewhere, so far as known,—is the standard roughing tool for heavy cuts. Some of the tools were self-hardening or musket steel, and some were of well-known brands of tool steel.

It will be observed that the practice in these shops in regard to metal-cutting tools is not in the line of absolute uniformity ; various steels are used, and individual tool grinding on large wet stones and on emery grinders is the rule, instead of having all tools forged from one steel and ground by one man in the tool-room, which is the more generally approved course. Nor are air hoists used. The shops are, however, most liberally supplied with cranes and travelling hoists of other kinds. The very great use of air hoists in many other large establishments makes its exclusion from the Baldwin shops noticeable.

After the second side of the pair of side frames has been finished with the flat nose tool, ¾″ feed, the top lines are squared down, and the whole job finished in the time named,—8 hours. This job might easily take 3 days in a shop with ordinary planers and planer hands, and the rapidity of its execution is only a fair sample of the swiftness with which both tool and hand operations are carried on. The tools are driven to the power limit in all cases, the machine feeds not being put on when feeding by hand can hurry the work, which is thus made very severe on the driving gear. Various makes of tools are used, *only one or two well-known names of tool-building firms being made conspicuous by their absence, their product probably not being* *considered stiff enough or sufficiently powered to meet the output requirements.*

Milling and planing operations are mixed, many cuts being partly planed and partly milled, and some of the milling machines are very plainly over-powered and under-framed, and generally wanting in diameter and support in their smaller parts,—hand wheels, feed screws, and so on,—the "limit drive" hunting out and exposing every weak point of their construction. It seems strange indeed to eyes accustomed to New England shops to see fine and unsuitably delicate machines driven to their utmost belt pull in a manner that will certainly put them in the scrap heap very promptly; but they are held to fully earn their money by great and rapid production.

Summed up in few words, the Baldwin shops' theory appears to the writer to be this: Every machine tool has, when new, a fixed metal-removing potentiality, and can cut a certain number of cubic inches of iron or steel or brass into chips before it is worn out; and the sooner it can be forced to cut those chips, the sooner it has reached the end of its total earning powers, and the sooner it has brought in its profits.

Perhaps a still broader view of the situation would justify the formulation of this policy in square foot of shop floor-surface terms; a locomotive building shop may be said to have a locomotive production of so much per square foot, per day or year, and any policy which will increase the square-foot production must certainly increase the profits arising from its use.

Either of these supposititious statements involves a policy which leads to the speediest possible wearing out of every machine tool in the plant as a needful step in economical machine production.

So far as the machine tools alone are concerned, it is easy to drive them to the limit of belt power. They are dead,—without will or volition,—and work to the limit of their capacity without protest of any sort. But machine tools require human attendance, and no means has yet been devised for producing workmen without decided ideas as to the extent, scope, and limit of their individual muscular efforts. The workman in general may be said to mentally decide upon the fit limit of his own labor, and many superintendents have found it very difficult to induce men to extend and enlarge their ideas in this particular. Indeed, workmen in general very promptly resent any attempt to make a day's work greater than they have mentally decided it should be. Briefly, again, it is easy to drive machine tools, but how shall machine-tool tenders, the lathe and planer and milling machine hands, be themselves driven to drive the machine tools to the limit of the belt pull?

The Baldwin workmen do drive themselves, or allow themselves to be driven. The visitor sees that at the first glance. Purely hand operations involving the use of purely muscular power are urged and driven and rushed to the limit of the workmen's strength, precisely as the tools are driven to the limit of their powers.

For instance, a workman in the act of reaming a bolt hole in the coupling flanges of a pair of locomotive cylinders with a fluted reamer $1\frac{1}{4}''$ diameter first drives the reamer, taper $\frac{1}{16}''$ to the foot, into the drilled hole in the flanges with heavy blows of a hand hammer, until the reamer is as far in the hole as it needs to go. Then, with an open end wrench $36''$ radius, he turns the reamer once round in the hole, using great muscular effort in so doing. All of this practice is out of the common. Fluted reamers are delicate and expensive tools, and the production of a smooth, true, perfectly-tapered hole is commonly held to require some skill and a good deal of care, and a distinct regard for the preservation of the reamer; and in many shops of high repute no workman would be permitted to drive a taper reamer as described, or to finish a taper hole by turning a fluted reamer once round in it. It probably would be difficult to find a workman in, say, the Pratt & Whitney or Bement & Miles shops who would use either the reamer or himself as described, of his own free will, or to please any one in authority. Yet in the Baldwin shops such violent muscular exertion is not the exception, but the rule, and the men are all perfectly contented, ready, and, if their appearance signifies, willing and eager to drive themselves and every tool put into their hands to the extreme limit of their powers of continued effort. How is this willingness ot the men to work hard secured?

In the first place, every operation has its piece price, paid directly to the workman. In many New England shops certain of the workmen known as contractors take the production of an entire piece or machine at a fixed price, hire their own workmen, usually at day wage, and depend on their own push and knowledge of every step in the manufacture to produce the job at a cost, to themselves, as much as possible below the contract price which the firm pays the contractor for the finished article. This method may, and in most cases does, result in surprisingly cheap production, and in very substantial profits to the contractor, in which the workmen do not share at all. The workmen are docile: the contractor is intimately acquainted with the capabilities of each, and furnishes brains and push for all: and, as he has the power to hire and discharge his men, his authority is unquestioned, but seldom exercised, as the successful contractor is always in sympathetic touch with his hands. In the Baldwin shops there are no contractors, and the foremen have no possible way of increasing their salaries beyond their day pay; the piece price is paid directly to the workmen, who are thus enabled to make extra exertions bring extra money.

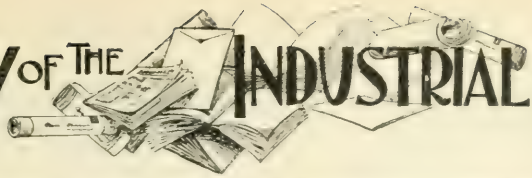
But even in this case workmen often decline to exert themselves, and refuse to overstep certain established lines of shop etiquette. Not long ago it was common for a machinist to refuse point-blank to keep two planers or two lathes running at the same time; this step in rapid production is now generally conceded, and it is commonly the rule for a man to run as many tools as he can well attend, and sometimes more. But workmen are not yet all of them ready to "make horses of themselves," as they term it, to please any one, even if the hard work does bring increased pay. Why, then, is the Baldwin machinist so willing to work hard?

First of all, the management takes a superlative standpoint. It is the largest locomotive shop, turns out the most and greatest variety of locomotives, gets the greatest effect per man from its hours of labor, and pays its men the highest wages, of any locomotive-building firm in the world. In reality it pays the men a fixed price for each operation, and insists on such a production as will make its workmen earn large weekly wage at shop piece prices. If a man does not earn this large pay, he is followed, without harshness but persistently, until one of two things happens,—either his pay reaches a satisfactory figure, or he gets tired of the constant pressure, feels that he is out of his class, and voluntarily leaves the shops. In no case was any workman, when asked his views of this system, heard to express any desire for a change. The preference was always given unqualifiedly for the piece-price system, which is subject to small, but steady, reductions, as improved tools and methods make reductions possible.

Beside this natural and just preference for piece prices, there is a strong pride manifested among the workmen, which is easily understood; and here is another cause, perhaps the most potent of all, in the personality of the management of the shop in the past and present. Mr. Baldwin himself was a very kind, humane, and just man, as well as a mechanic of unusual ability. He helped and counseled his men. Mr. Parry was another man of equally noble and admirable character, and continued the policy inaugurated by Mr. Baldwin. Every mechanic who shows powers beyond the sphere of his employment is advanced until his limit of usefulness is reached. There is no favoritism; efficiency is the only standard; hence every man feels that he is made of the best possible use by both the management and himself, which is a most happy and valuable frame of mind for any workman in any shop. In consequence of this pushing of men forward, there are a great many very bright youths about the Baldwin shops who have no fixed place, but are put wherever their services are of the most use, and these have the prospect of advancement immediately before their eyes at all times ; there are, on the other hand, many employees of very long standing, 30, 40 and even more years of steady work being very common. Between the young men, eager to do all they can, and the old hands, thoroughly satisfied that they always had full pay and full consideration for all their services, it is easy to see how the management can maintain its policy of driving machine tools to the limit of belt power with the hearty concurrence and coöperation of their workmen.

The mechanical and commercial success of the Baldwin establishment, its continuance and constantly-increasing growth, while generations of its managers pass away, and the contentment of its workmen give the strongest possible testimony to the correctness of its internal policy. It must be held as proved that machine tools should be regarded and treated as containing certain total possibilities, which are most profitably exhausted in the most rapid manner possible : that it is an error to prolong the life of a machine tool by light performance demands : and that the sooner a tool is worn out in effective production the better and more profitable the management under which that machine tool was carried through its useful career from the hands of its maker to the scrap heap.

REVIEW OF THE INDUSTRIAL PRESS



WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES, GREAT BRITAIN AND THE BRITISH COLONIES.

INTRODUCTORY.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those **articles of** the month which are deemed of most importance ; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United **States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.**

We hold ourselves ready to supply—usually by return mail—the full text of every article reviewed **or indexed, and our charge in each case is regulated closely by the cost of a single copy of the journal from which the article is taken.**

☞ The price of a single article is ordinarily 15c. ; those indicated by an asterisk (*) 30c. ; by a dagger (†) 45c. ; and above this, the price is given just after the number. In ordering from us care should be **taken to *give the number* of the article desired, not the title alone.**

The entire Review is conveniently classified into the recognized divisions of applied science—everything pertaining to "Architecture and Building" appearing under that heading, while "Civil Engineering" is given under that title, and so on alphabetically throughout. The titles and addresses of the majority of the journals reviewed are given below. Serials are usually indexed only on the appearance of the first installment; the original notice may be found by consulting previous lists. Ill=Illustrated ; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell coupons—represented here in miniature.

The price of these coupons is 15c. each, or fifteen for $2, forty for $5, and one hundred for $12.

Simply fill in the number, and your address. A stamped envelope does the rest. No letter-writing is required.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their great convenience and economy.

This Coupon will be received by us in payment for any 15 cent article catalogued in "The Technical Index" of the ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be required for each 15 cents thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on

Engineering Magazine Co., *New York:*

Please send Article No ______________ *to the following address.* ______________

____

____

NOT GOOD
UNTIL STAMPED BY US

THE PUBLICATIONS REGULARLY REVIEWED.

Age of Steel. *w.* $3. St. Louis.
American Analyst. *f.* $1. New York.
American Architect. *w.* $6. Boston.
Am. Chem. Journal. *b-m.* $4. Baltimore.
Am. Eng. and Railroad Journal. *m.* $3. N.Y.
Am. Gas Light Journal. *w.* $3. New York.
Am. Geologist. *m.* $3.50. Minneapolis.
Am. Jour. of Science. *m.* $6. New Haven.
American Machinist. *w.* $3. New York.
Amer. Mag. of Civics. *m.* $3. New York.
Am. Man. and Iron World. $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. N. Y.
Amer. Soc. of Irri. Eng. *qr.* $4. Denver.
Am. Soc. of Mec. Eng. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Archæologist, The. *m.* $1. Columbus, O.
Architect, The. *w.* 26*s*. London.
Arch., Build. and Dec. *m.* $2. Minneapolis.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. N. Y.
Arena. *m.*. $5. Boston.
Aust. Mining Standard. *w.* 30*s*. Sydney.
Banker's Mag. *m.* $5. N. Y.
Banker's Mag. *m.* 18*s*. London.
Bankers Mag. of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s*. London.
Boston Jour. of Commerce. *w.* $3. Boston.
Brick Builder. *m.* $2.50. Boston.
British Architect, The. *w.* 23*s*. 8*d*. London.
Builder, The. *w.* 26*s*. London.
Bul. Am. Geog. Soc. *q.* $5. N. Y.
Bul. Am. Iron and St. Asso. *w.* $4. Phila.
Bul. of the Univ. of Wisconsin.
Calif. Architect. *m.* $3. San Francisco
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Rev. *m.* $1.50. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan. *m.* $2. Meadville, Pa.
Chem. Trade Jour. *w.* 12*s*. 6*d*. Manchester.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s*. 6*d*. London.
Contemporary Review. *m.* $4.50. London.
Cosmopolitan. *m.* $1.50. New York.
Domestic Engineering. *m.* $2. Chicago
Electrical Age. *w.* $3. New York.
Electrical Engineer. *w.* 19*s*. 6*d*. London.
Electrical Engineer. *w.* $3. New York.

Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Journal. N. Y.
Electrical Plant. *m.* 6s. London.
Electrical Review. *w.* 21s. 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24s. London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7s. 6*d.* London.
Engineer. *s-m.* $2.50. New York.
Engineer. *w.* 36s. London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineering. *w.* 36s. London.
Eng. and Mining Journal. *w.* $5. N. Y
Engineering Magazine. *m.* $3. New York
Engineering Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m,* 7s. London.
Eng. So. of W. Pa. Proc *m.* $7. Pittsburg.
Fairplay. *w.* 32s. 6*d.* London.
Fire and Water. *w.* $3. New York.
Fortnightly Review. *m.* $4.50. London.
Forum. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engrs' Mag. *m.* 6s. 6*d.* Birmingham.
Gas World. *w.* 13s. London.
Geol. Mag., The. *m.* 18s. London.
Heating and Ventilation. *m.* $1. N. Y.
Ill. Carpenter and Builder. *w.* 8s. 8*d.* London.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Industry. *m.* $2. San Francisco.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age. *w.* $4.50. New York.
Iron and Coal Trades. *w.* 30s. 4*d.* London.
Iron & Steel Trades' Jour. *w.* 25s. London.
Iron Ind. Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Chem. So. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Jour. Assoc. Eng. Soc. *m.* $3. St. Louis.
Jour. Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. As. *q.* $2. New London.
Jour. Polit. Economy. *q.* $3. Chicago.
Jour. of Royal Inst. of Brit. Arch. *s-q.* 6s. London.
Journal of the So. of Arts. *w.* London.
Locomotive Engineering. *m.* $2. N. Y.
Machinery. *m.* 50 cts. N. Y.
Machinery. *m.* 9s. London.
Manufacturer and Builder. *m.* $1.50. N. Y.
Manufacturer's Record. *w.* $4. Baltimore
Marine Engineer. *m.* 7s. 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Mag.
Mechanical World. *w.* 8s. 8*d.* London.
Metal Worker. *w.* $2. N. Y.
Milling. *m.* $2. Chicago.
Min. and Sci. Press. *w.* $3. San Francisco.
Mining Industry. *w.* $3. Denver.
Mining Jour, The. *w.* £1. 8s. London.
Mining Review, The. *w.* $2. Denver.
Mining World, The. *w.* 21s. London.
National Builder. *m.* $3. Chicago.
National Car Builder. *m.* $2. New York.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. N. Y.
Nineteenth Century. *m.* $4.50 London
North American Review. *m.* $5. N. Y.
Paving & Mun. Eng. *m.* $2. Indianapolis.
Plumber and Decor. *m.* 6s. 6*d.* London
Popular Science Monthly. *m.* $5. N. Y.
Power. *m.* $1. N. Y.
Practical Engineer. *w.* 10s. London.
Procd. Engineer's Club. *q.* $2. Phila.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1 New York
Railroad Gazette. *w.* $4.20. N. Y.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway Times, The. £1. 5s. London.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. N. Y.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. N. Y
Scientific Machinist. *s-m.* $1.50. Cleveland, O
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y
Social Economist. *m.* $2. N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
St. R'y. Elec. News. *m.* $2. Minneapolis.
Street Railway Gazette. *w.* $3. Chicago.
Street Railway Journal. *m.* $4. New York
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. N. Y.
Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
Trans. of the Wis. Acad. Madison.
Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.

ARCHITECTURE & BUILDING

Steel-Frame Building Construction.

A MEETING and banquet of the New York Architectural League was held on June 5, at which an address on the above subject was delivered by Mr. Geo. B. Post. A synopsis of this interesting address is printed in *The Engineering Record* (June 15). Mr. Post traced the advent of the tall office-building to the introduction of passenger-elevators in the Equitable Life Insurance building, New York, in 1868. Notwithstanding Mr. Post has been professionally connected with some of the most notable tall buildings in the country, he very positively declares them to be "nuisances unless proportioned to the width of the streets they stand upon.' After the passenger-elevator, the metal cage construction of framework was the next impulse imparted to the tall office-building. But defects in this system are pointed out.

Mr. Post expressed great hopes of "being able next year to invite the assistance of the members of the League in securing legislation restricting the heights of buildings," and remarked that "under these circumstances it was an instance of the irony of fate that he should have been called upon professionally to construct some of the highest office-buildings, and perhaps the very highest office-building, ever yet built,—namely, the one now in progress for Mr. H. O. Havemeyer, on the site of the old *Herald* office at the corner of Ann street and Broadway, New York city. The necessity of erecting several of these structures had led Mr. Post to give very careful detailed study to cage construction, its difficulties and dangers, and to attempt to introduce some modifications, which he hoped were steps in the direction of their removal. If calling the attention of the members of the profession to those defects of the cage, and setting their inventive faculties on his work, results, as he hoped, in making steel-cage construction as surely permanent and lasting as brick or stone, the objects of his remarks will be more than accomplished."

As ordinarily constructed, "with no provision for preservation except what is offered by painting and the masonry" where built into the wall from 4 to 12 in. thick, Mr. Post points out three dangers: "first, from the corrosion of the metal; second, from expansion produced by great exterior conflagrations; and third, from inadequate provision for wind strains. Several investigations and consultations with chemists and experts have established the conclusion that paint is effective as a preservative of iron or steel in direct proportion to the amount of linseed oil which it can carry, the most being carried, as a rule, by the lightest pigment; consequently lamp-black, if it would dry, would be as good as any. Graphite comes next, and he intended to use it. If inspection could be perfect, red lead would probably make one of the best of paints, but it has the property of setting very rapidly in oil, and, if it has begun to set before it is applied, is almost worthless. To be at all efficacious, paint must be applied in dry weather to steel which is clean, free from foundry scale, and absolutely dry."

Contrary to Mr. Berg (see review in department of civil engineering, in the present number), Mr. Post disapproves of the use of iron oxid paints, on the ground that the life of such paints corresponds with the life of linseed oil, which he fixes at about 6 years, "and, when the oil has oxidized, the residuum of the paint consists of iron rust that will promote corrosion instead of preventing it.

"Illustrating the way in which, under certain circumstances, steel and iron will sometimes corrode when it ought not to, or be preserved when it could be expected to corrode, Mr. Post showed some samples of iron beams taken from the ceiling over the boiler-room in the old *Times* building, New York, and from a girder in Sedgwick Hall, the former county court-house of Lenox, Mass., both of which were completely destroyed by corrosion in 40 or 50 years' service. He also exhibited a farmer's hoe dug up out of the mud under the foundations of No. 18 Exchange Place, New York city, where it had probably been buried about 50 years, without any marked injury, the surface being apparently in about the same condition as when buried, and covered with a black film.

"The second danger by which the cage construction may be menaced arises from the possibility of fierce exterior fires in the adjacent building. In a cage structure 200 or 300 ft. high with riveted connections of proper form and ordinary protection, Mr. Post was of the opinion that the temperature distortion from a greater exterior conflagration would be sufficient to expand the lines of support and twist the cage out of shape, so as to produce dangerous strains and distortions, and possibly shear the connection rivets. In either case the building might be left in a dangerous condition. In ordinary structures he considered the danger from wind strains to be much less than has been supposed; otherwise, many buildings that now stand securely must have been destroyed. Nevertheless the architect is rash who ignores wind strains in the design of a high building."

These samples of the address will show its general practical character. No doubt, when this matter is brought before the legislature, the influence of the Architectural League, led by an architect of the ability and standing of Mr. Post, will be able to secure the desired legislation.

Acoustics of Public Buildings.

UNDER the title "Sound in Its Relation to Buildings" Mr. H. W. Burrows read an interesting paper (March 25) before the Royal Institution of British Architects, which, published in the *Journal* of the institution, was reprinted in *The American Architect* (May 18). The paper is long, and comprises a list of world-famous buildings noted for acoustic effects bad and good, and also a reference to the later writings on the subject scattered through books, technical periodicals, and transactions of scientific technical societies. The following is an abstract of some of the more interesting and important parts of the paper.

The inherent difficulties of the subject are great, and they are by no means lessened, but amplified, by the strange divergence of opinion at times expressed upon one and the same point,—one observer pronouncing a building to be good for sound, while another condemns it. This may, in part, be attributed to the different uses to which the building is subject. "To put it simply," says Rev. Compton Reade, speaking of churches, "just as that concert-room which is best for voices is worst for instruments, and *vice versa*, so the church most suited for oratory is least suited for harmonic effects." But, conversely, other writers contend that there is no instance of an apartment where music is heard to advantage where a speaker does not find himself free from restraint, oppression, or a necessity for exhaustive exertion. Therefore, our problem is plainly to build our apartment, whatever it is intended for, as if it were a music-room, and we are safe.

It is only by a patient accumulation of facts that scientific truths can be established, and no cursory dismissal of a subject, on the ground of its having been already well discussed, should be tolerated. The probable existence, for instance, of such a constituent of our atmosphere as argon was not even suspected till quite recently.

As the limits of distance to which an average speaker can be heard are about 90 ft. in the direction to which he speaks, 75 ft. on each side, 30 ft. to the rear, and 45 ft. vertically, authors have endeavored to group buildings into classes,—those, first, which fall within the range of voice, and in which, therefore, sound proceeds from the speaker to the listener by direct radiation; and, secondly, those which exceed the above dimensions, and in which the sound must be conducted, assisted, and reinforced by the design, construction, and materials.

Many buildings without the slightest obstacle between speaker and hearer, and under one roof, are decidedly bad for sound, giving rise, in some instances, to confusing reflections and consequent echoes, and in others to great decay of sound through the dispersal of the sound rays upward in the large open roofs required to cover single spans of wide dimensions.

"If rectangular rooms are adopted, some authors consider they are improved if one dimension is longer than the other. The late Dr. Brewer considers that the best form for the interior of such rooms is that their length be about two-thirds greater than their breadth, in order that the sounds reflected from the side walls may mingle with the voice and strengthen it. As sound-waves are propagated in spherical layers from their point of origin, it has often been imagined and urged that curved forms are the best to adopt for acoustic reasons, and many opinions have been expressed both for and against this view. The ellipse is one of the worst forms of plan, as is proved by the acoustic failure of the Albert Hall in London. The circular plan has given widely varying results. Octagonal plans are prolific of echoes. Plans with curved ends having sides produced somewhat in the manner of a basilica have been successful."

The London county council chamber is cited as an example.

"The amphitheatrical type of plan has often been adopted for lecture halls and theaters, and it certainly possesses many and distinct advantages, so far as the seating capabilities are concerned, and in many instances has proved successful from an acoustic point of view; but there are notable exceptions, among which may be mentioned, as chiefly defective from an excessive sonorousness, the semi-circular room of the Fine Arts School at Paris, which is described by Radau as being beautifully decorated, but miserable in this respect, as are, also, the great amphitheatres of physics and chemistry in the Jardin des Plantes, and the amphitheatre of physics in the College of France. Efforts have been made in each case to remedy the defects, but with little success. One of the examples often quoted as a successful application of this type of plan is the lecture theater at the Royal Institution, London, plans and sections of which are given in Prof. T. Roger Smith's work. Among buildings planned as elongated rectangles with rounded ends which are successful acoustically may be mentioned the Cincinnati Music Hall, the Concert-Hall at Leipsic, and the Queen's Hall, Langham Place. In the last-named plan the truncated, trumpet-shaped orchestra is a noticeable feature; as in nearly all other examples I have noticed, the curve at the back of the orchestra is concave, parabolic, semi-circular in outline, or a compound curve not easily definable."

"The horseshoe type of plan has been adopted in a large number of theaters, but with varying success, depending in great part upon the materials of which the buildings are constructed, and influenced largely, among other things, by the boxes, which, Scott Russell says, are favorable to the laws of sound, while Zamminer declares them to be monster traps for strangling it."

As to churches and cathedrals, it has been urged by many that the avenue plan is objectionable, and that the columns which carry the arcade cast sound shadows. In this matter we again find most contrary opinions expressed. Scott Russell says: "In a long gallery with wings, the sound cannot be reflected back or rolled along so as to create disturbance, because it goes round and escapes into the transepts; consequently these are favorable to the law of sound." Radau conversely insists that "the transepts of a church are most inconvenient to a speaker, because of the repeated reflections from these recesses, which greatly weaken the sound of his voice." Thus the author justifies his position that neither precedent or authority is a sure guide in acoustic designing, and that neither the failures or the successes of the past guide modern architects in this matter, particularly in designing churches. The effect of details, arrangement of seats, materials, etc., occupy much space in the paper, of which the perusal leaves the impression that the science of acoustics as related to architectural construction is unsatisfactory.

A Plea for Brownstone.

ARCHITECTURE AND BUILDING (June 22) has copied from the New York *Mail and Express* an article by Mr. R. S. Taite, relating to brownstone, which points out reasons for some past architectural failures in the use of this material, and the causes for its flaking, which has been one of the chief objections raised against it as a building material.

It is frankly admitted that "the introduction of competing stones has been a great advantage." The time when New York knew nothing of residential architecture is recalled. "Suddenly there came a change, and, in place of long rows of houses identically alike, there suddenly burst upon the community a craze for variety, which, while it was a relief for the time, soon led to excesses and atrocities in the way of rainbow-colored blocks and nondescript façades of all kinds. It was the same in the country districts, where the rage for Queen Anne architecture soon degenerated into a debauch of Mary Ann house building. The reaction there has come in an appreciation of simplicity and a liking for the old Colonial style, and there has been undoubtedly a similar reaction in town that assures the continued ascendancy of brownstone.

"Not that we shall ever go back to the typical 'brownstone front' of 20 years ago; we have learned a thing or two since then, and one of the most valuable things that the architects have taught us is that we can have beauty in this most staple of stones just as well as in its more gaudy competitors. I remember that a few years ago one of our wealthiest citizens permitted his architect to make the first serious attempt at an architecturally beautiful brownstone residence. The result was pleasing to those who know little of architecture, and was admired by laymen somewhat enthusiastically for a few months until one of our best and most good-natured critics spoke of the building in a magazine article as a 'brownstone cigar-box with architecture appliqué.' The criticism was just, and it was taken in good spirit, and we may possibly date from the day of its utterance the immense strides that have been made in using this material in a truly artistic and workmanlike manner. That this is now done no one need spend more than a half a day on the upper west side to convince himself. Everywhere he will find residences of constantly varying design and of pleasing appearance (both to those who understand the principles of architecture and to those who do not) in which by far the largest part of the visible surface is brownstone."

The artistic sense of the possibilities of brownstone which architects have acquired will, in the opinion of this writer, continue to make brownstone dominant in New York architecture. This opinion, however, is based upon the assumption that the best qualities of this material will be used. The assumption also implies that the stone shall be quarried at the right season of the year. This implication leads to the statement of some facts that will be new to lay readers. "Investigation will show that nearly all the sins that have been charged against brownstone should be laid at the door of careless and grasping contractors. Twenty years ago the facilities for quarrying and storing the stone were nothing like what they are at present, and a contractor who desired to finish a building within a given space of time would frequently rush an order to one of the quarries at a time of year when to fill it meant and could only mean to furnish inferior stone not fit for use in buildings intended to last. The practice of all the Connecticut brownstone quarries at present, I am told, is to shut down completely during the winter months, and enough stone is kept on hand to supply demands during the time. In this way exfoliation, that has caused some people to reject this stone in the past, is prevented. Another important fact is that, when stone is fresh quarried, it contains a certain amount of moisture, which evaporates or crystallizes upon exposure. In other words, stone, like lumber, requires seasoning."

As to the propriety of using brownstone for very tall buildings, by reason of its reducing the amount of light in opposite buildings and in the street, Mr. Taite says: "This may be true in exceptional localities where many very high buildings frown down upon a narrow street, but I think very little of the argument as to buildings facing wide streets, and nothing whatever of it in the upper part of the city. I am convinced that for three-quarters of the year the glare of a white building would be more objectionable in this climate than such darkness as might be caused by brownstone during the other 3 months. And our snowy, white marble buildings require not more than a year to become dirty, and not more than three to be disreputable, and not more than ten to seem almost coal-black. Of course they are never cleaned, and the consequence is that many of us will soon wish that they had been built of a stone that does not change its color and does not show dirt." The assertion that marble buildings "are never cleaned" is rather too sweeping; in this case "never" might, as in the precedent established in the opera of "Pinafore," be appropriately softened to "hardly ever."

Artistic Domestic Architecture in America.

THE *New England Magazine* for June has a paper by Mr. Barr Ferree on the subject named. The author dates "the development of Artistic American Architecture" from the close of the Philadelphia Centennial Exposition; but he does not consider the impulse given to American art by that splendid collection as the sole cause of the revival of art in architecture. "The educated architect, trained especially for his profession and in a professional manner, is scarcely older in this country than that time. Not that all our present architects are the young men this statement would seem to imply; but the road to the practice of architecture is now almost wholly through the schools for preliminary study, or through the practical work of a trained architect's office; the result is much the same, whether the preliminary schooling is had or not. The road through the carpenter's shop and the work-bench, which in the past produced some faithful men, but few artists, has been closed for all time. The present revival has accomplished that, if it has failed in other things.

"The training of architects and the spread of artistic culture have gone hand in hand. Guided by the one, inspired by the other, people to whom the very word architecture was long unfamiliar now profess a more or less general acquaintance with the art, and, when they build, insist on structures of a certain standard of artistic excellence, depending for the most part on the ability of the architect whom they employ, and on the taste, if not on the accuracy, of their own judgment. There is still a vast deal to be done, People of the broadest culture, of refined temperaments, are still paying for the erection of the most inartistic structures, and architects without the smallest artistic quality are still commanding lucrative practices. In a genuinely artistic age such things would be impossible. It is a significant indication of our own position in history that we can tolerate them, and calmly rank them among the peculiarities, if not the glories, of our civilization."

The complicated character of American architecture, arising from diversity of requirements, has resulted in confused and indiscriminate growth, and there is no style that is distinctly American. "Of the artistic architect we have but a few, perhaps no more than can be counted on the fingers, perhaps no more than can be counted on those of one hand. But we are no worse off than other nations in this respect, for architecture is so largely a matter of business and of management, and success in it is so often dependent on everything but artistic skill, that the truly artistic architect can only be a rarity even under the most favorable circumstances. And then there is the extraordinary fact that the best of architects, the men whose names are most familiar to the world, whose work is most in evidence and who have the most work to do and the most important, are constantly doing the things they ought not to do, and that in the most extraordinary fashion. But we have architecture in America that is not wholly the product of the artist-architect, work very good in itself, admirably suited for the purposes for which it is intended, and dowered with a grace of beauty that lifts it above the ordinary, though its creators may not all of them be properly called artists in the truest sense. It is this ability of so many of our architects to produce interesting buildings which renders the outlook so hopeful and which makes American architecture in its best forms—and this, it should be remembered, is the latest —among the most interesting now to be found anywhere." The country house "takes first place in the development of artistic composition in American architecture" by reason of its "importance in number and in example." The suburban dwelling and semi-detached house of modern cities ranks next. But the most pronounced success has been attained in the country house. "Its progress has been real and marked, and its future development must be watched with the greatest interest. There is a freedom from restraint in designing a country house that admirably falls in with the beauty of its situation. Artistically, it is the greatest distinction American architects have achieved that they have so admirably solved this one problem. There is still much to be done before the same quality will have penetrated to other fields of labor. In many other groups of buildings much progress has been made, and an architect who has in the dwelling given evidence of artistic ability is quite likely never to fall back into an inartistic mood when undertaking other problems. The artistic dwelling points the way for similar improvement in other fields."

Waterproofing Brick and Sandstone.

AT a recent meeting of the Australian Association for the Advancement o Science, says *The British Architect*, an account was given of experiments made with the view of ascertaining the length of time that brick and sandstone are rendered waterproof or protected by oil. The oils used were the three commonest and most readily obtainable for such purposes, viz., linseed oil, boiled linseed, and the crude mineral oil known as "blue oil," used for preserving timber. The weatherings were made upon a flat portion of the laboratory roof fairly exposed to the sun and weather. Good, sound, machine-made bricks were experimented on. The amount of oil and water taken up by the sandstone was very much less than that absorbed by the brick, although the area of the sandstone cubes was much greater than that exposed by the bricks. Equal amounts of raw and boiled oils were absorbed; the blue oil, however, was taken up in much greater quantity by both brick and sandstone, but by the end of 12 months the whole of the 13½ oz. of blue oil had apparently evaporated away and the brick had returned to its original weight. The bricks treated with raw and boiled oils remain unchanged. After the second oiling in November, 1890, and exposure for nearly four years and two months, they had practically retained all their oil, inasmuch as they had not lost weight, and were also nearly impervious to water.

The singular feature of this is the alleged continued imperviousness of the bricks notwithstanding the apparent disappearance of the blue oil, as indicated by the weight. A curious physical problem is here presented; provided the testing by weight was correctly performed. In the absence of a cause there can be no effect.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

32409. The Congressional Library Building at Washington. Ill. George Grantham Bain Am Arch–June 8.) 4500 w.

*32414. Durham Cathedral. Dr. Greenwell in the Durham Advertiser (*Arch*–May 31.) 6000 w.

*32415. Bricks. Anon. (*Ill Car & Build*–May 31.) 2500 w.

*32420. Some Characteristics of Saxon Buildings. Baldwin Brown (*Brit Arch*–May 31.) 2500 w.

32504. Hollow Clay Construction. Ill. (Brick–June.) 1300 w.

32558. Steel Frame Building Construction. Ill. Synopsis of remarks of George B. Post (Eng Rec–June 15.) 1400 w.

*32609. Delphi. Ill. (*Builder*–June 8.) 5200 w.

We supply copies of these articles. See introductory.

*32610. Iron Work. The Grand Period. Ill. J. Starkie Gardner (*Builder*–June 8.) 2500 w.

†32687. Stray Notes on Building and Construction in Ancient India (*Ind Engng*–May 18.) 2700 w.

32700. The Massachusetts State House. Ill. Albert Winslow Cobb (Arch & Build–June 22.) 4800 w.

32702. A Plea for Brownstone. R. S. Taite, in N. Y. Mail and Express (Arch & Build–June 22.) 1300 w.

*32747. The Early Development of the Christian Church. William J. Anderson (*Builder*–June 15.) 5000 w.

*32753. Artistic Domestic Architecture in America. Barr Ferree in New England Mag. (*Arch*–June 14.) 4000 w.

†32762. Annual Exhibition of the Chicago Architectural Club. Ill. P. B. Wight (In Arch–June.) 2800 w.

32764. Concretes, Cements and Mortars. Fred. T. Hodgson (Mfr & Builder–Jan.) 2200 w.

32766. A Norwegian House in England. A. T. Sibbald (Am Arch–June 22.) 1600 w.

32843—$1.50. Address to Students by Francis C. Penrose (*Jour Roy Inst of Brit Arch*–June.) 5000 w.

32844—$1.50. The Legal Position of Architecture in Relation to Certificates and Awards. James Andrew Strahan, with Discussion (*Jour Roy Inst of Brit Arch*–June.) 13000 w.

32845.—$1.50. The Value of Simplicity in Architecture. Ill. I. Halsey R. Ricardo. II. Basil Champneys III. Francis C. Penrose. With Discussion (*Jour Roy Inst of Brit Arch*–June.) 11800 w.

32846.—$1.50. Style Individuality, and National Tradition. Extract from Address of A. N. Patterson (*Jour Roy Inst of Brit Arch*–June.) 2700 w.

32847.—$1.50. Fever Hospitals. Ill. T. W. Aldwinckle (*Jour Roy Inst of Brit Arch*–June.) 25500 w.

32848.—$1.50. Architecture and the Arts of the Netherlands: Monsieur Van Tsendyck's Great Work. J. Tavenor Perry and J. Starkie Gardner (*Jour Roy Inst of Brit Arch*–June.) 4500 w.

32849—$1.50. Notes upon the Architecture of China. F. M. Gratton, with Discussion (*Jour Roy Inst of Brit Arch*–June.) 15200 w.

32850.—$1.50. Some Observations on the Notes of Foreign Travel Left by Mr. Wolfe, Sir Charles Barry, and Others. Arthur Edmund Street (*Jour Roy Inst of Brit Arch*–June.) 2200 w.

*32911. The Condition of the Parthenon. Ill. Somers Clarke (*Builder*–June 22.) 1600 w.

*32912. The Durability of a Stained Glass Window. G. E. W. (*Builder*–June 22.) 1600 w.

*32920. Planning Small Houses. T. W. F. Newton. (*Ill Car & Build*–June 21.) 1000 w.

*32921. The Decoration of St. Paul's. W. B. Richmond, with Discussion (*Jour Soc of Arts*–June 21.) 9000 w.

32930. A Brief History of the Beacon Hill State House. Thomas A. Fox (Am Arch–June 29) 5500 w.

32932. The West Front of Peterborough Cathedral. From Building News (Am Arch–June 29.) 1100 w.

*32948. Surface and Color Treatment of Terra-Cotta. William D. Gates (Br Build–June.) 3000 w.

*33028. The Charterhouse. Anon. (*Ill Car & Build*–June 28.) 2200 w.

*33060. Coventry Municipal Buildings Competition (*Builder*–June 29.) 2800 w.

*33061. Architectural Modelling. E. S. Prior (*Builder*–June 29.) 2200 w.

Serials.

18857. Electrical Science for Architects. Ill. Russell Robb (Am Arch–Began Jan. 13, 1894—11 parts to date—15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (Br Build–Began Jan., 1894—18 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (*Plumb & Dec*–Began March, 1894—15 parts to date—30 cts. each).

26069. Modern Steel Fireproof Construction. Ill. F. M. Small (Arch & Bldg–Began Oct. 13, 1894—8 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. W. J. Eden Crane (*Ill Car & Build*–Began Nov. 9, 1894—12 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (Arch & Build–Began Nov. 24, 1894—8 parts to date—15 cts. each).

28494. Bricks and Terra Cotta (*Builder*–Began Jan. 5—23 parts to date—30 cts. each.)

28805. Fire-Proof Floor Arches. Ill. George Hill (Br Build–Began Jan.—4 parts to date—30 cts. each).

29253. The Guilds of the Medieval Workers in Stone. Edward C. Weaver (Stone–Began Feb.—Ended June—5 parts—30 cts. each).

31880. Practical Masonry and Stone-Cutting. Ill. Fred T. Hodgson (Stone–Began May—2 parts to date—30 cts. each).

31911. The So-Called Colonial Architecture of the United States. Ill. O. Z. Cervin (Am Arch–Began May 18—7 parts to date—15 cts. each).

32206. The Blackpool Tower. Ill. (*Engng*–Began May 24—Ended June 21—3 parts—30 cts. each).

32660. Practical Carving. Ill. Dominick A. Walsh (Stone–Began June—1 part to date—30 cts).

32701. The Study of Buildings To-day and in the Past. F. C. Penrose (Arch & Bldg–Began June 22—Ended June 29—2 parts—15 cts. each).

32947. Architectural Terra Cotta. Ill. Thomas Cusack (Br Build–Began June—1 part to date—30 cts).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

President Morison's Address.

THE annual address of President Morison before the American Society of Civil Engineers at its twenty-seventh annual convention at Hull, Mass., June 18, departed from the usual custom of such addresses, and dealt with what the speaker styled "The New Epoch,"—the epoch of the manufacture of power. *The Engineering Record,* which prints a very full report of the proceedings, publishes also the full text of this address. The "new epoch" is treated as still in its incipiency. It is predicted that it "will finally make the human race a single great whole, working intelligently in ways and for ends which we cannot understand."

"It is not too much to predict that, when the full effects of the manufacture of power are realized and the world has passed through the development which the next 10 centuries will see, the time when man began to manufacture power will be recognized as the division between the ancient and the modern, between ignorance and intelligence, between the national strife, which may then be classed as barbarism, and the new civilization, whatever that may then be called."

This epoch means more to the profession of civil engineering than to any other. "The manufacture of power is the work of the engineer; the inventions which have led to it were made by engineers,—in fact, it has made possible the profession of the civil engineer. The civil engineer is, briefly, a man who, with the knowledge of the forces and materials around him, uses that knowledge in the design and construction of engineering works. His business is to design the tools by which the sources of power in nature are directed for the use of man. A body of civil engineers should include the choicest minds in every branch in the engineering profession. . . . . We welcome into our society all branches of engineering, but not all engineers. We welcome every engineer who applies a knowledge of the powers of nature to the design and construction of engineering works; we welcome the architect who uses this knowledge in his designs and construction; but the architect who treats his profession as a fine art to decorate a construction which he cannot design belongs elsewhere. Intelligent knowledge of the great powers in nature is the fundamental requirement for a civil engineer. On this substructure a superstructure of actual design and construction must be built to make the complete professional man."

Qualifications of civil engineers to meet coming requirements are indicated. "The physical laws of power and strength are mathematically exact, and admit of no trifling. As the epoch progresses, the requirements for each individual will become more complicated. The theologian and the metaphysician may claim that an education based on the laws of nature leaves out the highest part of existence; the biologist and the physician may claim that matter endowed with life is a higher organism than the inanimate matter with which the engineer has to deal. But, however true these claims, their laws have not the mathematical rigidity, the clear definition, and the thorough discipline which mark the laws with which our profession works. The engineer cannot shield himself under doctrines or theories which he accepts, but cannot understand. Dealing with accurate, definite laws, and guided by the corrective touch of physical nature, the education of the engineer will become more necessary, more thorough, and more exact than that of any other professional man. This is the training which the civil engineer of the new epoch must have. This knowledge he must have, or he must be classed as a workman.

"The civil engineer in the new epoch must sink the individual in the profession. The engineering work of the future must be better work than has ever yet been done. The best work is never done by separate men; it is only accomplished when professional knowledge so permeates all members of a profession that the work of one is virtually the work of all. The first steps are made by individuals, but the best results come later. The name of Watt will ever be identified with the successful introduction of the steam engine, and nothing should be allowed to belittle his reputation; but there are ten thousand men to-day any one of whom can build a far better engine than James Watt ever could; they can do it, because they are imbued with all the work the engine-builder has done for more than a century; they do it as members of a profession, who are all working together. In the Middle Ages Gothic cathedrals were built throughout Northern Europe; they are exquisite works; no modern architect can approach their beauty; the reason is that the men who built the Gothic cathedrals worked together as members of a guild which was thoroughly imbued with the spirit of building these churches. In no period of the world's history has marine construction had any significance compared with what it has to-day, and it is because the great shipbuilders are working together, each having the practical benefit of what they are all doing; they are working together as members of a profession rather than individuals, and their work is becoming more uniform and more perfect.

"The civil engineer of the new epoch must be a specialist. No man can learn to design all the tools by which the powers in nature are to be directed. The work is too great for one man to master. The best results will only be obtained by concentrating effort in a single line. But though the civil engineer must be a specialist, his specialty must not be of a narrow kind; he must have that general knowledge and training which make the liberally educated man; the real difference between a liberal education and a special education is that one teaches the student to use his mind, and the other gives him information. The civil engineer must have had the mental discipline which qualifies the mind to investigate kindred subjects beyond the limits of his own specialty; his education must be broad enough for this, or he will not be a civil engineer. The knowledge of his specialty will be only part of his education; the mental discipline will be more.

"And last, the civil engineer of the new epoch must fill many positions which are now held by men of different training. The knowledge of the tools, both large and small, which men are using must be the strongest qualifications for their use. Accurate engineering knowledge must succeed commercial guesses. Corporations, both public and private, must be handled as if they were machines, and the men who will so handle them will find their best training in the education which will make the best civil engineers."

The duties and responsibilities of the American Society of Civil Engineers, its objects, and its relations to other engineering societies are then alluded to, and a general discussion of engineering tools completes an unusually interesting discourse. A general classification of engineering tools is made into those "which manufacture power," those "which transmute power," those "which transmit power," and those which make up "the rank and file of miscellaneous tools."

Iron Bridge Painting.

In our June number we noticed a report on preservation of iron structures prepared by Mr. M. E. Gerber. In line with that able report is a report by Mr. Walter A. Berry (made in the course of his professional duties) on the "best paints and methods for painting iron bridges, viewed from the standpoint of a railway engineer," extracts from which are printed in *Engineering News* (June 6).

The fact that an article or method is widely used, though not absolutely conclusive, is regarded as at least presumptive evidence that it is useful and adapted to its purpose. The information upon which the report is based has been obtained from about thirty different railways. It is difficult to overestimate the value of a mass of information so obtained and directed to a single practical subject. Unfortunately the communications thus received are privileged, and in the extracts Mr. Berg gives only "his own personal deductions and conclusions."

He classifies the paints in common use as follows: "(1) Metallic or iron paint, consisting of oxid of iron and linseed oil. (2) Red lead paint, consisting of red oxid of lead and linseed oil. (3) Asphalt paints, consisting of mineral and artificial asphalts or coal tar, alone or combined with each other, and frequently mixed with metallic bases, oils, and other materials. (4) Carbon and graphite paints. (5) Patent paints."

Mixtures of white lead are unfit for priming except where light finishing coats are to be used. "The use of light colored paints, the superiority of which, as claimed by the manufacturers, consists in the preponderance of dark-colored bases, such as asphalts, carbons, red oxids, etc., is not warranted, as the lighter the shade desired, the larger the quantity of foreign light-colored pigment that has to be used to counteract the dark color of the base, thus diminishing the amount and destroying the advantages, if any, of the much advertised base." Ochre paints have not had an extensive trial, but have been recommended by Dr. Charles Dudley, the chemist of the Pennsylvania railroad, The differences in the conditions and requirements for painting iron work of bridges compared with either wood or underground pipes or ships' bottoms are alluded to. In the first case atmospheric influences are unimpeded.

Metallic or iron paints consist, or ought to consist, of oxid of iron ground in linseed oil. In such paints, however, as are obtainable in commerce, "adulterations and improper applications have been so common as to have caused" much to be said and written against iron paints. In a prime condition, and properly applied, iron paint has the merit of cheapness, and it has been used for a long time, giving many proofs of its usefulness for a variety of purposes. Not only the iron oxid, but also the linseed oil, must be pure to secure good results. Such paints, "followed up in due time with additional coats of the same material, will give very good practical results for iron bridges, in spite of theoretical arguments against the use of iron paints in general for priming iron." The practical difficulty remains of getting good paint, at the cheap prices sought by purchasers; and there is a "tendency of the purchasing and administrative departments of a railway to judge the quality of materials and workmanship by the question of cost."

Red lead paint is the red oxid of lead mixed with linseed oil. It is improved for bridgework by addition of lamp-black, which causes it to set less quickly, and changes the tint from a glaring red to a chocolate color. It is one of the best inert paints. It should not be too long mixed before application; else its tendency to set quickly will render it hard to apply. "Its use is becoming very general for railroad-bridge painting, especially for priming coats, and after toning down with lamp-black or graphite, and also for finishing coats, wherever light-colored finishing coats are not called for. It is nearly as cheap as oxid-of-iron paints, if its greater covering capacity, as claimed by the manufacturers and a great many users, is considered; while, on the other hand, it becomes as costly as any high-colored paint on the market, if a low average covering capacity is assumed. On this point the statements are most conflicting. The manufacturers claim a covering capacity of from 750 to 1200 sq. ft. The results of painting about 3000 lin. ft. of bridging on the St. Louis & San Francisco Railway would seem to be about 400 sq. ft. for the first coat, and about 1000 to 1100 sq. ft. for the second coat. The fact of the adoption of red lead on such a large number of railways, however, certainly seems to indicate that its covering capacity and price, with the practical results attained, must be favorable, as compared with the cheaper iron oxid and asphaltum paints which it replaces.

"As to adulteration, it can be said that the quality of the pigment, which has to be purchased in powder form, can be readily tested by simple tests, and that in the paint trade it is considered that red lead bought of the large manufacturers, not of middlemen, can be relied on for purity. In other words, there is less chance for adulterations to exist than in purchasing ready-mixed patent or iron paints." Manufacturers of other paints on the market, however, deny the superiority of red lead paint, and attribute its extended use on railways to a stimulation of purchases by energetic advertising and active and able salesmen employed by the "Lead Trust." The author thinks, however, these statements not warranted by facts. An admitted objection to red lead paint is its tendency to run on slanting or vertical surfaces; but this tendency can be largely eliminated by adding lamp-black or graphite, or a little japan.

The term "asphalt paint" covers so many mixtures sold under that name, in which mineral and artificial asphalts and coal tar, alone or combined with each other, are found, that it is difficult to define what "asphalt paint" is, as sold mixed, ready for use. "A properly-constituted pure asphalt paint (not a coal tar, benzine, and mineral or fish oil mixture) would seem to be worthy of extensive trial, especially for priming iron. Cheap so called asphalt or asphaltum paints are not included in this recommendation, as the price of the article excludes pureness. This fact, combined with the uncertainty as to what the cheap mixture really contains, makes it preferable (if a cheap paint has to be used) for the purchaser to buy, at the same cost, or generally even at less cost, iron oxid powder and pure linseed oil, and have the mixture made under his own supervision."

Notwithstanding this, an asphalt paint made by a New York house, and consisting of asphaltum, linseed oil, turpentine, and Kauri gum, is highly spoken of as a new departure in bridge painting,—namely, the introduction of a varnish-like finish and consistency offering a much more impervious coating than the ordinary oil paint. Graphite and carbon paints have given satisfaction, but it is advised that they be obtained from firms of the very best standing.

Besides this general discussion of the qualities of paints, there is a discussion, occupying about six columns, of essential elements and conditions for securing good results with paints in general. This covers very thoroughly the entire field of selection of materials and application of paints, preparation of surfaces, adaptability to special uses, the supervision of men employed to do the work, etc., and closes with the following recommendation:

"It is very desirable to obtain promptly some full-size comparative tests,—*i. e.*, paints which seem to offer sufficient good features to warrant these tests being made, so as to establish whether these paints will give better results than red lead or iron oxid paints, especially for priming iron:

"Dr. Dudley's Paint Formula: 39 lbs. French ochre, 1 lb. lampblack, 54 lbs. raw linseed oil, and 6 lbs. japan.

"Black Bridge paint, of Edward Smith & Co., 45 Broadway, New York city.

"Bessemer paint, of Messrs. Rinald Bros., Philadelphia, Pa.

"Graphite silica paint of Joseph Dixon Crucible Co., Jersey City, N. J.

"Carbon primer of Sherwin-Williams Co., Cleveland, O., and 178 Fulton street, New York city.

"Graphite paint of Detroit Graphite Manufacturing Co., Detroit, Mich."

Submarine Blasting at the Iron Gates of the Danube.

A DESCRIPTION of the operations whereby the removal of the rocks which obstruct passage of vessels of draft exceeding 6 ft. between Bazias and Sibb in the river Danube—rocks which have long been collectively known as the "Iron Gates"—is given in *Transport* (June 14). This obstruction to navigation, which attracted attention even in ancient times, was tolerated, after some public attempts at removal and many abortive proposals for the much-needed improvements, until Sept. 18, 1890, when the work of removing 360,200 cu. meters of rock commenced. Nearly two-thirds of this rock will be removed from shallow water along shore; the rest has to be taken from the river channel, and 270,000 cu. meters will be required for dams and dikes. The channel at the "Iron Gates" will be cut open to a width of 89 yds. for a distance of 3000 yds., and to a depth of 6 ft. 6 in. below low-water mark. Dikes will be built that will further increase the depth.

The most notable feature of the work is the method of submarine blasting employed by the engineers in charge, some of which is accomplished by a system of mining very similar to that employed by General Newton in removing the Hell Gate rocks in the channel of the East river at New York.

"Col. Lauer's method of subaqueous blasting, which was at first regarded as the only one available, was found unsuitable for some portions of the work, although it gave most satisfactory results in the preparation of the bridge foundation at Peterwarden, on the Danube. The system is carried out by mooring in the usual manner a barge with wrought-iron framework over the front and with a number of apertures through which rods made of gas-tubing can be slipped down to the river-bed from a fixed point overhead. On the end of the rod a charge of 2.2 lbs. of dynamite in a tin case, fixed to a short wooden rod, is attached to a suitable holder. The charges are fired by electricity and, as a general rule, only the wooden lengthening piece is broken. The rocky bed of the river is removed in steps with the free side down stream, so that all the small *débris* is swept away by the current. Difficulty was experienced in working by this system at the 'Iron Gates,' for, when a piece of rock 6 ft. deep had to be removed, it had to be taken off in three or four layers, and, when the attempt was made to start the second layer, the shots had very little effect when the rock was soft, and it seemed as if the rock had been compressed by the first set of explosives. There was, in addition, the danger of leaving needle-like points projecting, which would have been most dangerous to passing vessels. There was a further difficulty, but of a less serious character, caused by the wooden lengthening pieces becoming so tightly jammed into the iron rods that nothing short of burning them out was sufficient to remove them."

For heavier work, as at Greben point, the system of chamber mining was adopted. "The spur of the mountain had an almost vertical face towards the river, and operations were commenced on it at different levels simultaneously; and a tunnel was driven to carry away the spoil. The first material removed was pumped into the river, and sufficient ground was made to build locomotive sheds and workshops, and to form a connection with the cluster of workmen's houses. When the rock was cut back sufficiently far from the shore, chamber-mining was resorted to. The chambers were very simple in shape. A heading 3 ft. wide by 4 ft. high was driven about 80 ft. quite straight, and then a chamber 6 ft. 6 in. cube was blasted out at right angles to it. This was charged in the usual way, and the heading was closed, first with brickwork set in cement, and then with dry stone-work. One of the chamber-mines fired last year had a breast of 20 yds. and a height of 33 yds. A charge of about 4 tons of carboazotine was used, with the result that about 700,000 cu. ft. of rock were thrown down. The largest blast was fired in May, 1894, when 2,100,000 cu. ft. of rock were dislodged by a charge of 12 tons of second-grade dynamite."

The most difficult part of the work was, however, at the Inez Rapids. Here there are two systems at work, the more important of which is that of the Ingersoll-Sergeant Rock-Drill Company. The Fontane system is employed at Izlas and Tachtalia. "The Ingersoll 'scow,' as the makers term it, is provided with spears, one at each corner, up which the scow can be raised by hydraulic jacks fed by a Worthington pump. By this means the scow can be lifted out of the water so as to rest on the four spears, thus giving a working platform independent of the movement of the water. As the current is strong in this part of the river, and carries a good deal of detritus, a protecting tube, held by a special iron framework, and pressed against the river bed, surrounds the drilling bars. When the drilling of a hole is finished, it is washed out by a jet of water, and the charge of dynamite is lowered into the bore-hole through the projecting tube, which is split along one side to allow the wires of the electric fuse to pass. When all the boreholes for one blast have been charged, the scow is lowered into the water and floated away to a distance of about 50 ft., the charges being fired simultaneously by electricity."

It is stated that the Ingersoll scows at Inez, though there has been some complaint of their want of steadiness, have, on the whole, given good satisfaction. In the Fontane system two barges are emptied by a platform on which the drills are mounted, and, while it gives a greater range of work, its want of steadiness, due to weakness of construction, is a subject of complaint.

The Baltic Canal.

THE imposing celebration of the completion of the Baltic canal has elicited so many comments upon this new and great waterway that we hardly know which to select for special review. *The Engineer* (June 14) states that it is the "realization of a plan long cherished by both Germany and Denmark." The German ocean and the Baltic are now connected by a canal "answering all requirements from a naval as well as a commercial point of view. The idea of such a canal is by no means new; similar schemes have been in existence for centuries. Christian III. of Denmark, in 1539, recognized the importance of such a waterway; Wallenstein, in 1626, had actually got workmen together to commence operations when his deposition put a stop to them. Oliver Cromwell conceived the idea of buying the town of Wismar from Sweden as a preliminary step toward a similar scheme. In all, some sixteen plans, more or less practicable, have in the course of time been brought forward and received serious consideration. The present canal is the work of Mr. Dahlstrom, a Hamburg shipowner, who, in 1878, attempted to raise the necessary capital by forming a company. In this he failed; but he handed over to the government full particulars of all his plans, preliminary surveyings, and experiments which had been carried out under the superintendence of Mr. Boden."

"The new canal leads from Brunsbuttel, on the right shore of the lower Elbe, forming a slight curve through Holstein in a north-east direction to Rendsburg, whence it continues in an easterly direction, reaching the Fjord of Kiel at Holtenau, within the immediate vicinity of the great naval station. The port and bay of Kiel form one of the largest and most perfect anchorages in the world, and the selection of Kiel as naval port of the North German Union in 1867, and now of the German Empire, was the only possible one."

There are no locks except at the two ends of this canal. These great locks are chiefly for the purpose of protecting the canal from strong tides and currents. That on the Baltic terminus will need to be used only when storms raise the tides to an unusual height. At the other end the rise and fall of the tides is so notable that, except for an interval of about 3 hours between tides, the lock-gates must be closed. The completed work has cost $36,300,000, and the construction has occupied only 8 years.

Engineering News (June 20) gives the dimensions of the prism, etc. "The normal section of the canal has a bottom width of 65.6 ft., a surface width of 183.7 ft., and a depth of 30.5 ft. These dimensions are based upon rules providing for the passage of a warship of 72.16 ft. beam and a draft of 24.4 ft.; and the width at keel-level is to be sufficiently great to pass with due care two ships of ordinary commerce of 38.4 ft. beam and 21.3 ft. draft. Of curves of less than 2500 m. radius the width of the canal is increased, according to the formula, $26 - \frac{\text{radius}}{100}$; the enlargement for 1000 m. radius being 52.48 ft. The resistance to motion in this canal is but little more than in an open river. In sections where stone is abundant the sides of the canal are paved with 12 in. of granite laid on 8 in. of gravel. In other sections slabs of beton are used for paving, 8 in. thick and 8.85 ft. long by 4.92 ft. wide. The locks are each 720 ft. long, with a useful length of 492 ft. and a free width of 82 ft. In design they differ little from locks usually used for similar purposes. The gates are handled by hydraulic power, and as the pressure on these large gates is very considerable, each gate has in it a supplementary relief gate, which is only shut down after the main gate is closed. This feature is claimed as a novelty in lock construction by the chief engineer."

The Harlem River Ship-Canal.

THE *Iron Age* (June 20) publishes a good account of this piece of engineering, with a map. The work has presented no special difficulties, and is chiefly of local interest. It affords a waterway between Manhattan island, the site of New York, and the main land for vessels of 8 ft. draft, or less, through the widened and deepened channel of the estuary known as Spuyten Duyvil creek, a distance of 1¾ miles. The waterway will permit the passage of nearly all vessels plying the Hudson river, scarcely any of which have a draft exceeding that named. The *Iron Age* article is chiefly historical. The canal was formally opened June 17.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

*32402. Improving the Delaware at Philadelphia.—A Notable Engineering Work. Ill. John Birkinbine (Eng Mag–Aug.) 4000 w.

†32616. Expansion Bearings for Bridge Superstructures. Ill. George S. Morison (Am Soc Mech Eng–June.) 400 w.

32971. The Casseuil Drawbridge. Ill. From La Nature (Sci Am–July 6.) 600 w.

Canals, Rivers and Harbors.

*32426. The Principles of Harbor Construction. Anon. (*Trans*–May 31.) 1800 w.

32475. The Chicago Drainage Canal. Ill. (Sci Am–June 15.) 1100 w.

32510. The Harlem River Improvement and Ship Canal. Ill. (Sci Am Sup–June 15.) 1600 w.

32532. The Hussey Delivering Dredge. Ill. (Eng News–June 13.) 2000 w.

32533. The Handling of Dredged Material. Editorial (Eng News–June 13.) 5000 w.

*32572. The Jonage Canal. Ill. (*Eng*–June 7.) 1900 w.

*32607. The Baltic and North Sea Canal (*Trans*–June 7.) 2000 w.

32662. The Harlem River Ship Canal, New York. Ill. (Ir Age–June 20.) 1800 w.

32685. The Completed Canadian Soo Canal (Sea–June 20.) 700 w.

32691. The North Sea and Baltic Ship Canal. Ill. (Eng News–June 20.) 1100 w.

32692. The Canadian Canal at the Sault Ste. Marie (Eng News–June 20.) 500 w.

32693. The Harlem River Ship Canal (Eng News–June 20.) 3800 w.

*32710. The Baltic Canal. Ill. (*Eng*–June 14.) 2000 w.

*32730. The Iron Gates of the River Danube (*Trans*–June 14.) 2000 w.

32806. The Chicago Drainage Channel. Ill. (Sci Am Sup–June 29.) 2200 w.

*32910. The North Sea and Baltic Canal. Ill. (*Builder*–June 22.) 2500 w.

*32990. Dredge Construction in the Clyde (*Trans*–June 28.) 1800 w.

Hydraulics.

†32635. Analysis of the Tremont Turbine. Ill. DeVolson Wood (Am Soc Mech Eng–June.) 1500 w.

32937. Notes on Hydraulic Elevators. Ill. (Mach–July.) 500 w.

Miscellany.

32476. Limes and Cements. Extract from paper by Charles D. Jameson (Sci Am–June 15.) 3300 w.

†32625. Rustless Coatings for Iron and Steel. Third Paper. M. P. Wood (Am Soc Mech Eng–June.) 16000 w.

32816. The New Epoch and the Civil Engineer. George S. Morison (R R Gaz–June 28.) 6500 w.

*32826. Notes on the Construction of the East River Gas Tunnel. Walton I. Aims (Jour As Eng Soc–May.) 6000 w.

32855. President George S. Morison's Annual Address (Eng Rec–June 29.) 8000 w.

†32986. Cements. K. Horgan E. (*Ind Engng* June 1.) 700 w.

Serials.

28498. Thames Bridges. Ill. (*Engng*–Began Jan. 4—16 parts to date—30 cts. each).

31702. Cement Testing. Cecil B. Smith (Can Eng–Began May—Ended June—2 parts—15 cts. each).

31829. The Chicago Main Drainage Channel. Ill. (Eng News–Began May 16—6 parts to date—15 cts. each).

31871. Glasgow Harbor Tunnel. Ill. (*Engng*–Began May 10—Ended June 28—4 parts—30 cts. each).

32334. The North-East Sea Canal. Ill. (*Engng*–Began May 31—5 parts to date—30 cts. each).

32686. The Rushikulya Project. Ill. (*Ind Engng*–Began May 18—1 part to date—45 cts).

32736. The Titicus Dam. Ill. (Eng Rec–Began June 22—1 part to date—15 cts).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Ventilation of Hospitals.

In our July number we mentioned in this department an experiment in ventilation carried to an unsuccessful termination at the Cambridge Hospital,—namely, an attempt to cool the air used for ventilation by passing it over the coils used in winter for hot-water heating, these coils being kept at, or nearly at, the temperature of the water in the city mains which was pumped through them. The temperature of the water so circulated was too high, and the area of the surface of the coils was too small for effective cooling. The subject of improved ventilation for hospitals appears, however, to be again coming into prominence. This is particularly the case with reference to new hospitals projected or in process of construction. The *Lancet* (London) has recently described and discussed an instalment for ventilating the new General Hospital at Birmingham, England, in an article of which a considerable portion has been reprinted in *The American Architect.*

This instalment is intended to purify both the inflowing and outflowing air,—the first with reference to interior, and the second with reference to exterior, sanitation. The system, applicable to all hospitals, is, therefore, of greater importance as regards hospitals for infectious diseases.

The architect of the building, Mr. Wm. Henman, recognizing the efficiency of air filtering as successfully applied in the "Key" method of ventilating hospitals, infirmaries, and schools, conceived the idea of also filtering the outflowing air, and of disinfecting it, to prevent any active germs of disease from escaping to the exterior.

The hospital is now in process of erection, and is expected to reach completion in about 2 years. The determination of the success or failure of Mr. Henman's scheme will, therefore, have to await the completion and occupation of the building. It is, however, based on correct principles, and we are satisfied that, if skilfully carried out, it will be demonstrated to be an important and useful innovation. Moreover, the experiment will be on a scale to develop all practical difficulties that possibly may arise. If these can be surmounted, its general feasibility for hospitals, large and small, will be established. Twenty million cu. ft. of air per hour will be required. It is no small undertaking to filter and purify effectively this large volume. The screen for this purpose will have a surface of 2000 sq. ft.

"In applying the Key scheme to a hospital, a selection is first made of a position uncontaminated by surroundings (or of more than one such position, if the buildings are extensive), where air can be drawn in towards an extended screen, kept moistened with water and periodically flushed to free it from the large amount of dirt which it intercepts. The screen is formed of a series of cocoanut-fibre cords stretched vertically, and interlaced with copper wire to keep them in position. On the other side a coil of steam or hot-water pipes is placed to prevent freezing in the winter, and on the inside are other heating coils arranged so that by means of doors or louvres the air passing through or under them may be regulated. It is then forced onward by means of a rotary fan or air-propeller, set in motion by steam, water, gas, or other power,—preferably an electric motor,—and finds its way to the several rooms, wards, or corridors by means of a wide and lofty horizontal duct and up-flues, all calculated to the required areas, at the base of which are more heating coils, together with a simple contrivance by which both the volume and temperature of the air-supply to any separate part of the buildings can be adjusted to a nicety. The air enters where required by means of trumpet-mouthed openings, at about two-thirds the height of the story, so as to disperse evenly throughout the apartment; and at the same time it expels an equal amount of air, principally through openings provided on the same side of the room as the inlets, up-flues of the proper sectional area, into ducts in the roof, and thence to the open, through valved and louvred turrets or flaps, four-sided, so that outer movement of the atmosphere shall exert no adverse influence upon the outflow. These outlet air-valves are so constructed as to place the air within the building under a slight pressure of about 4 ounces per square foot in excess of the outside atmospheric pressure at the time."

The system is named after its inventor, a Glasgow engineer. "Mr. Henman takes no credit for the method by which a suitable supply of air is cleansed, tempered, humidified, and propelled into the buildings, but acknowledges his indebtedness to Mr. Key for the assistance he has rendered in working out his ideas in connection with the methods he adopts. It is simply proposed that air so cleansed, tempered, and humidified should be propelled through wedged-shaped openings in the ceilings, and by means of a simple form of spreader evenly distributed throughout the wards and corridors. The feature which Mr. Henman claims to be a novelty is the placing of a screen (somewhat similar to those employed by Mr. Key at the air-intake) at the head of every bed, and keeping the same charged with a disinfecting fluid. An outlet flue will be provided at the back of each screen, so that, as fresh air is constantly being propelled into the ward, an equal quantity will be forced through the screens, all other outlets being stopped; consequently, almost immediately the air becomes contaminated, it will again be purified, even before it actually leaves the apartment, and, thus purified, will pass up the flues into the open air."

The charging of the screens with the disinfecting solution is done by a pump connected with small cisterns, and driven by the same power that impels the fan. Steam-pipe coils will be employed to warm the air delivered into the wards in cold weather. "As regards the cost of the method proposed, the necessary apparatus is stated to be quite inexpensive and easily applied, and Mr. Henman is prepared to show that buildings can be erected and equipped at considerably less cost than is now expended upon hospitals relying only upon the ordinary means for ventilation, without any appliance for purifying the air emitted."

Plans for Home Grounds.

A CORRESPONDENT of *Garden and Forest* wrote to that journal that he had 6 sq. acres of ground fronting on a river and gently sloping back from the stream. With these meager data supplied, he asked where would be the best place on the ground for erecting a dwelling-house, and requested that a book of plans for laying out the grounds be sent to him. Whereupon the journal named (June 19) makes this request a text for an editorial on the subject indicated by the title.

Notwithstanding the fact that the person asking for information shows by the manner of asking that he has the crudest possible ideas relative to the requirements, his case is considered "more hopeful" than that of "the average American citizen." The latter would walk about the place and "decide on the location of his future dwelling without any serious study as to how his house, with the other necessary buildings, the stable-yard, the carriage-approach, and other foundation-features of the scheme, could be most conveniently arranged, while the thought of preserving the natural beauties of the place would hardly enter his mind; and, if it was suggested that these beauties might be enhanced by careful treatment, he would probably decide that all such consideration could be postponed until his buildings were completed."

Published plans have small value except as they illustrate some special problem. It is always safe to begin with "a thorough investigation of the resources of any given property from a landscape point of view. It may have an attractive, distinct prospect, and a noble sky-line in some direction. It may be possible to command a view of a stretch of water which holds the light of the sky and brightens every surrounding object. The property may contain trees which are impressive from their size, age, and dignity of aspect. There will always be something in the contour of the land itself, in the vegetation that it contains, or in the outlook into the territory beyond its boundaries, which will furnish a motive for the intelligent treatment of a place. With such a reasonable end in view, the designer will pursue his purpose thoughtfully, and will escape the dangers of those who only have a vague and misty notion that they want to make a pretty picture. Of course, this leading motive will vary in every instance. One who is developing a place on the banks of a Florida river would hardly be successful if he were controlled by the same ideas as if he were planning a homestead in a mountain glen and amid the grandeur of mountain scenery. But in either case the effort would be to discover and unfold the charm which is peculiar to the spot,—that is, to develop its native beauty rather than to trick it out with some imported ornament."

As to the average American citizen's attempt to make a thing of beauty out of a spot of land, the want of success is usually the most conspicuous outcome. "No one but a genuine artist can discern the latent and possible beauties of any piece of ground, and no one but a constructive artist, in the best sense of the word, can adjust a place to the practical necessities of every-day life, and yet, by turning difficulties into opportunities, can preserve its essential and poetic charm. It comes to this at last. The laymen who endeavor to develop their grounds on purely natural lines, with an eye to preserving the spirit and sentiment of the place, whether it be of wildwood, or seashore, or mountain gorge, or smiling meadows and cultivated farm land, may fail, and probably will fail, of the very highest attainment. And yet so long as they treat nature with reverence, or even with respect, they will not make such pretentious failures as do they whose first effort is to obliterate everything that is native and natural because it is common, in order to make a lawn of such a shape as they have seen in a map, and dress it in such exotic finery as is usually named in the planting list which accompanies the ready-made plan."

Designing Radiators.

In a paper published in *Domestic Engineering* Mr. Leicester Allen criticises the modern tendency to load steam and hot-water radiators with ornament in relief, and also some defects in design which reduce efficiency as compared with cost. "Excessive height in proportion to base is one of the features deprecated. One reason assigned for this feature in design is that a radiator whose height is large, as compared with the size of its base, can be manufactured more cheaply per square foot of surface than lower ones, and radiators are sold with reference to their rated surface in square feet. By such disproportion the mean efficiency of the surface is reduced. Another reason is that the same amount of surface in a tall radiator occupies less floor-space than a lower one having the same number of square feet of surface, and, especially in cities, it is desirable to economize floor-space.

"All who are familiar with the principles of the transmission of heat to air and surrounding objects by the surfaces of metal pipes must admit that the higher a vertical pipe is the less efficient it becomes, considered as a heat-imparting device." Another defect to which attention is directed, and which has been exaggerated "in the struggle to obtain radiators that shall look well in apartments, is the opposition to each other of broad surfaces at near distances." Now, while it is readily admitted that the action of contact of air flowing over the surface of a radiator is in all cases very much greater in its effect upon heat-transmission than the action of radiation, properly so called, still, the latter, in a well-designed radiator, can be made to aid materially in the total effect; and this is proved by the fact that, when radiators are covered by screens, perforated or otherwise, their effectiveness is much reduced, notwithstanding the air has as free access to the heated surface as before."

A criticism of the odd and contorted

shapes met with in some designs is also made. "Such a radiator may look pretty well when nicely bronzed and standing on the floor of a salesroom; but, in use, I should think it would be altogether such a nuisance as to grievously burden the hearts of good housekeepers. These creases and configurations are just the things to catch and hold dust, and the cleaning of fifteen or twenty of radiators of this kind in a first-class dwelling would make a neat woman with a rather high temper unpleasant company at times. The same thing holds with a stove; a plain one is easily kept black and shiny; one spattered all over with ornaments, such as mouldings, rosettes, and filagree work, gives double the amount of trouble. Speaking from experience checked by theoretical principles, I believe the best design for a steam or hot-water radiator is one that has very little ornament in relief; one that has a height not exceeding 30 in.; one that will expose to air and surrounding objects the maximum of radiating surface, properly so considered; and one that, though it may cost 3 to 4 cents per foot more than that of a radiator designed only to catch the eye of the purchaser by its ornate appearance while violating the laws of heat transmission, will be cheaper in the end to the purchaser than radiators of the kind criticised." Taken by and large, a low, flat, pipe-coil is probably the most efficient radiator ever yet devised; but it occupies so much space that it is not much used.

The Denayrouse Electrical Gas Burner.

ACCORDING to *Electrical Engineering*, quite a sensation was created a week or two ago by Professor Vivian Lewes informing the members of the Gas Institute at Edinburgh that a French scientist, M. Denayrouse, had discovered a means of increasing the illuminating power of gas something like fifteen times. Prof. Lewes had been made aware of the discovery during a visit to M. Denayrouse in Paris, and he had obtained permission to experiment with the new method of gas lighting and to make a communication upon the subject to the Edinburgh meeting.

In this invention M. Denayrouse had first been struck with the idea of applying the principle of the blow-pipe to the gas burner. He employs a lamp with a spherical shaped metallic body, and an incandescent mantle. In the body of the lamp is placed a very small dynamo, working a ventilator and receiving the current from a couple of small accumulators. The electrical energy required is exceedingly small, and is said to be only about 1-3 volt and 1-10 ampere. This, however, is quite sufficient to force a current of air through the mantle and to cause the gas to burn with remarkable brilliancy.

According to M. Mellet, the lamp has a density of 35 to 40 carcels, and consumes 7 litres of gas per carcel. Prof. Lewes had, however, been shown a lamp of 80 carcels (about 800 C. P.), and he was convinced that the light was quite as brilliant as an arc lamp.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*32401. Uninhabitable Houses in City Slums.—Some of the Causes, and a Remedy. William Stevenson (Eng Mag–Aug.) 3000 w.

*32404. Illuminating Gas for Heating Purposes.—A Coming Revolution Predicted. Ill. Frederick Siemens (Eng Mag–Aug.) 3000 w.

32464. Ventilation of Hospitals. From *The Architect* (Am Arch–June 8.) 2200 w.

*32468. The Dwelling House From a Sanitary Point of View. Isaac Young (*Plumb & Dec*–June 1.) 4500 w.

*32520. Designing Radiators. Leicester Allen (Dom Eng–June.) 1200 w.

32614. Plans for Home Grounds. Editorial (Gar & For–June 19.) 1200 w.

32735. The House Heating Boiler Question. How to Regulate. John W. Mills (Met Work–June 22.) 1500 w.

32738. A Combined Steam and Hot-Water Residence Heating Plant. Ill. (Eng Rec–June 22.) 1400 w.

*32755. The Ventilation of Buildings. John H. Kellogg (*Ill Car & Build*–June 14.) 2000 w.

*32884. The Drainage System of the Houses of Parliament. Ill. (*Eng*–June 21.) 2000 w.

Serials.

29334. Technical Subjects That Plumbers Should Know. F. Dye (*Plumb & Dec*–Began April—3 parts to date—30 cts. each).

We supply copies of these articles. See introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

Electricity on the Railroads.

WITHIN the past few weeks a number of very notable contributions have been made to the literature dealing with the present and future application of electricity on railroads. Besides the well-considered and valuable paper of Mr. F. J. Sprague, which appeared in the last number of this magazine, Mr. H. G. Prout has an essay of scarcely less importance in the *Independent* of June 6, Joseph Wetzler in *Scribner's Magazine* for May treats the subject in a popular way, and, finally, Dr. Louis Duncan, the newly-elected president of the American Institute of Electrical Engineers, gave an inaugural address at the recent meeting of that body at Niagara Falls, in which the matter was discussed with great care from the standpoint of present practice. Further observations were made at the same meeting by Mr. C. P. Steinmetz, which, together with Dr. Duncan's address, may be found in the *Electrical World* of July 5. When this subject is discussed at length by those in every way qualified to express an opinion of real value, it is worth while to listen to what they have to say, especially when we find a railroad expert like Mr. Prout in substantial agreement with two such eminent electrical experts as Messrs. Sprague and Duncan, not only as to the essential facts of the present situation, but also as to the probable outcome of future development. Commenting on these papers, the *Railroad Gazette* of July 5 says in an editorial: " We advise railroad officers and directors to read this [Dr. Duncan's] address carefully, for it is very able and temperate. These are days when those who are responsible for the present and future prosperity of the railroads cannot sleep on their oars. It is their business to learn especially the possible uses and possible limits of electricity as a 'mode of motion' on railroads, and to learn this as fast as they can. As Dr. Duncan says, the safety of the steam roads is to make of electricity an ally instead of an enemy, and this before it is too late. A great deal of money has been wasted, and a great deal more will be wasted, in building electric railroads. A great deal of harm has been done by these railroads to the steam railroads, and more will be done; and, unfortunately, their capacity for harm is not gaged by the profitableness or the usefulness of these electric railroads. It long ago became an axiom that a bankrupt road is the most dangerous competitor."

All these authorities are in substantial accord in saying that it is a fundamental principle of economy in electrical transportation that the movement shall be in small and frequent units. As Dr. Duncan briefly and forcibly puts it: " The tendency of passenger transportation on the steam lines has been in the direction of the greatest electrical economy, while the tendency of the freight transportation has been in the direction of the least electrical economy." The conclusion to be drawn is that in certain fields of operation the electric service is likely within a few years to monopolize most of the passenger traffic,—to wit, all municipal or rapid-transit lines, whether above, upon, or below the surface all suburban service, within some limited, but not yet determinate, distance from the large cities (say 20 miles); interurban service between cities and large towns not too far apart; and most of the local business between smaller towns within the same limit, where the lines are permitted to occupy the surface of the public highways. So far, there is but little difference of opinion among these authorities, but, when it comes to the question of heavy express-train service between large cities, there appears to be considerable difference of opinion. Dr. Duncan and Mr. Wetzler are apparently much more sanguine of the future possibilities in this direction than are Mr. Sprague and Mr. Prout, neither of whom believe that the steam locomotive is likely to be very soon superseded either for freight or heavy and fast express service. Dr. Duncan gives a very complete description of the Baltimore plant, in which electric locomotives of massive construction, weighing 95 tons and having eight driving-wheels, are to be used to haul the ordinary steam trains, locomotive and all, through the tunnel under that city. He says of this plant that, if it proves successful, it will open a limited, but important, field for the introduction of large electric locomotives. It may, we think, well be doubted whether compressed-air would not perform this particular service with equal efficiency and at a far less cost than electricity.

The operation of "trolleyizing" the Nantasket Beach branch of the New York, New Haven & Hartford Railroad has attracted an amount of attention among newspaper writers which is apparently altogether out of proportion to its technical importance. The conditions are substantially those of a suburban line. It is about 7 miles long and has at present ten stations, though provision will be made for numerous additional stops by the way-trains. Motor cars and trailers will be used. The principal feature about this road is its careful and thorough construction, although it is stated, among other things, that the wooden poles are to be depended upon for the insulation of the conductors, no special insulators being used, which looks like a piece of superfluous folly. Many interesting particulars regarding the construction and arrangement of the permanent way and the electrical plant are given in the *Railroad Gazette* (June 14) and in the *Electrical Engineer* (July 3). An experimental run was made in the latter part of June, during which, according to newspaper reports, a speed of over 80 miles per hour was attained, which is possible, though not probable.

Did Reis Invent the Telephone ?

It is not likely to be an easy matter to reverse the verdict of the world that the true inventor of the speaking telephone is he who first gave it to the world in a form in which it possessed a sufficient degree of utility to be of at least some commercial benefit. One of the people who are obviously dissatisfied with this verdict is the well-known physicist, Professor A. E. Dolbear of Tufts College, who, in an article in the *Electrical Engineer* (June 19), once more advocates the not unfamiliar claims of Phillipp Reis of Germany to that distinction. He says: "That which makes the transmitter of to-day better than the Reis transmitter is the substitution of hard carbon, and nothing else, in the same place and for the same purpose for which platinum was used by Reis. If Reis had chanced to employ such carbon in the place of platinum, he would have had a good speaking telephone." So much may doubtless be granted, but, when the writer goes on to say that the first introduction of carbon was due to Professor Hughes of London, who gave it to the world, and that "the legatee failed to receive the legacy through crafty legality," he states that which a very little research would have shown—to put it mildly—to be a mistake. At least as early as September, 1877, the writer of this received a modest printed circular, setting forth the results of certain experiments made with carbon contacts by Emile Berliner; and the records of the patent office show that the same inventor, on September 10, 1877, filed a drawing of an apparatus showing a vibratory electrode carrying a bit of hard carbon in loose contact with a vibratory metal electrode. The experiments of Hughes were not made until January, 1878, and were not given to the public until May following. Of course it may be fairly assumed that Hughes knew nothing of what Berliner had done, and, naturally supposing himself to be the first inventor, freely undertook to give to the world that which, as it turned out, was, in fact, not his to give. Professor Dolbear also states that Mr. Yates of Dublin University placed a drop of water between the terminals of the transmitter, and "succeeded in transmitting speech perfectly, as one can see would be the case"; and he makes complaint that in the patent litigation over the telephone the testimony of witnesses to the fact was excluded. Of course it was; such is and ought to be the law. How many patents would ever be sustained if witnesses in behalf of infringers were permitted to testify from recollection as to the operation of a chance experiment witnessed years before, utterly unsupported by contemporaneous records? Professor Dolbear further asserts that, "when the [Reis] transmitter is spoken to gently, it transmits fairly well, in spite of the breaks which may occur." If our memory serves us, Professor Dolbear testified in one of the telephone suits some years ago that he had frequently talked through a fac-simile of Reis's transmitter, and had heard words and even whole sentences. But, when challenged by the opposing counsel to do the same thing in the presence of witnesses, using a Reis receiver, he found it utterly impossible, even after elaborate preparation, to transmit a single sentence intelligibly. All these experiments, including a stenographic report of every word uttered into the transmitter, and heard or not heard at the receiver, are given in the court records. The truth is that neither the instruments of Reis or those of Yates were of the slightest commercial utility. They were interesting and instructive laboratory experimental apparatus, but they were not telephones. The verdict of the world upon a question of priority of invention is not often, and perhaps not even generally, right, but in the case of the telephone nothing whatever has thus far been presented which appears to call for a reconsideration of the reiterated verdict of the federal courts.

The Niagara Plans.

It is an open secret that there has been a great deal of controversy over the authorship of the apparently successful electrical plans which have been adopted by the Niagara Company. It will be remembered that a suit was brought against that concern by Professor Rowland some time since for expert services, as a result of which that gentleman obtained a verdict for a considerable amount of money. In the *Electrical Engineer* (July 3) Professor Rowland has a communication in criticism of an interview with Professor George Forbes, reported in an English technical journal, which brings to light a number of very interesting facts. It seems that in September, 1892, Professor Forbes handed in a report containing his final recommendations to the Niagara Company as to the design of the electrical machinery of the famous power-plant, which may be summarized as follows: a two-phase alternating system, the dynamo giving a current of 10,000 volts and 8.3 periods per second; weight of revolving parts not to exceed 10 tons, and no iron in the armature. Professor Rowland states that, being called upon for a critical opinion of this design, he condemned it *in toto*, with the sole exception of the two-phase feature, and expressed the opinion that Professor Forbes's dynamo would not last a month, if it did a week, and now adds that the system at Niagara does not contain a single one of the features which he condemned, while, on the contrary, the features which he recommended are those in use at Niagara to-day "in spite of Professor Forbes's opposition to the very last." Professor Rowland says the revolving parts are heavy; the armature contains iron, step-up transformers are used, and a frequency of 25 periods per second has been adopted. He adds (presumably referring to the modifications introduced by the engineers of the Westinghouse Company): "My 'not less than 25 tons' for the revolving parts have become 40 tons, and my period of 42 or 33 has gone down to 25, and my revolving armature has become revolving magnets. As to whether the changes are for the better, time alone can show. As to whether 40 tons can be successfully revolved at two hundred and fifty turns per minute, a short time will decide." Replying to certain criticisms which have been made in reference to the professional propriety of a scientist bringing suit to collect pay for his services, Professor Rowland very justly and pertinently observes: "Everybody who knows me at all knows that money forms a very small portion among the objects that I seek. But, when men wish me to take my mind from those objects which I love, and devote it to their private money-making pursuits, I am then entitled to be compensated at the same rate as a first-class lawyer or physician. Furthermore, I have no right to degrade the profession of a man of science by undervaluing my own services. Let everybody recognize that the successful pursuit of science requires quite as much brains and knowledge as that of law, and that a scientific error often equals in disastrous consequences a legal error." In all of which most right-thinking persons will cordially agree with Professor Rowland.

The Telegraph in Mexico.

In the *Electrical Engineer* (May 29) Mr. Geo. H. Guy has a very interesting article descriptive of the governmental telegraphic system of our sister republic. No longer ago than 1885 the telegraphic service of Mexico was in the most wretched condition imaginable, being in the hands of unscrupulous politicians who, as the saying goes, "worked it for all it was worth." Finally President Diaz determined to include the telegraph in the plans for civil-service reform which have signalized his progressive administration. Mr. Saturino Islas, who had mastered every detail of modern telegraphy in the United States, was the man selected to reorganize the service, and was appointed director-general of telegraphs and invested with almost absolute authority. Sweeping changes were made in the staff, and the lines were thoroughly reconstructed and equipped with American-made instruments. The system now extends from the Gulf to the Pacific and from the frontiers of the United States to those of Guatemala, comprising 41,868 kilometers of line and 306 stations. The tariff is adjusted on a concentric zone system, the minimum rate being 20 cents for ten words and a maximum of $2. The lower charge covers the city of Mexico and a radius of 180 kilometers; beyond that there is an increase of 20 cents for each 180 kilometers or fraction thereof. Each office has a map on which are plotted nine circles having that office as their common center; a simple glance at the map informs the sender in what zone his message is to be delivered, and he can compute the tariff for himself. The Morse system is used throughout; duplex apparatus is installed in twenty offices, and twenty-five offices are equipped with automatic repeaters. The gross receipts for messages during the last fiscal year were a little over $1,000,000.

Electricity in a Great Library.

The new public library in Boston may fairly rank among the most notable institutions in the United States. One of its most unique features is the electric service, of which a very full description is given in the *Electrical Engineer* (June 5). The handling, delivery, and distribution of books is carried out by means of an apparatus of the general type of the well-known store service system. An attendant has only to pick out the book wanted, place it in a little car on a siding, and switch the car on to the main line, from which it runs at the rate of 500 ft. per minute to a special elevator, which automatically drops to the delivery room, waits there until the empty car comes back, and then delivers it to a return track leading to the siding from which it started. There are six stories,—or stacks, as they are termed,—each of which has a special carrier service and a special elevator. The track is of 8-in. gage; the cars are of wire, and will carry from 10 to 30 lbs. of books at each trip. The whole is operated by a 10 h. p. motor. The same motor operates a pneumatic-tube system, by which tickets, cards, etc., may be sent from one part of the building to another. The whole edifice is thoroughly ventilated by a large fan driven by a 50-h. p. motor. The switchboard is so arranged that the service within the building can be operated, either from its own plant or from the street lines of the Edison Electric Illuminating Company. The building is lighted by 3500 incandescent lamps, divided into five groups. The steam plant of the building consists of two tandem compound engines of 150 h.p. each,—sufficient to light a town of 5000 inhabitants. The exhaust-steam will be utilized in heating the building in cold weather. Apparently no pains have been spared to make all the appliances as complete as possible.

Municipal Electricity in Chicago.

In the *Western Electrician* (July 6) may be found some decidedly spicy editorial comments upon the much-lauded municipal electric-lighting system of Chicago. It will be remembered that, after this plant had been in operation a year or two, an apparently official announcement was published far and wide that that fortunate city was getting its streets lighted at the rate of $73 per lamp per year for a full-arc all-night service,—a statement which every well-informed electrical engineer knew to be necessarily untrue. The Chicago "figures" were quoted everywhere as gospel by the advocates of municipal ownership, and made more than enough trouble in various places for the owners of private plants furnishing street-lights in cities. In 1890 Mr. M. J. Francisco made an investigation on his own account,—as no itemized information could be got from the city electrician of Chicago,—and reached the conclusion that the real cost could not be less than $190 per year per lamp, exclusive of the salaries of the electrician and superintendent, and the expenses due to accidents. In 1890 a committee of Milwaukee aldermen visited Chicago for the express purpose of ascertaining the cost of municipal lighting, but met with very little success. The city electrician positively refused to give any information whatever, and, according to the Milwaukee report, informed the committee that the affairs of the plant were in such a state of chaos that he could not give even an approximate estimate of the actual cost. All this time central-station managers throughout the country, who were seeking city contracts, were continually confronted with the question: "Why can't you furnish light at $73 per lamp per year, as they do in Chicago?" It is safe to say that we shall never get a statement from the Chicago electrician which will inform us precisely how arc-lights can be run at a net cost of $73 per lamp per annum in a city of that size.

The Selection of Telegraph Operators.

At the recent meeting of railroad telegraph superintendents in Montreal, the question of the selection and training of operators received considerable attention, a special paper on the subject having been read by R. W. Pope, while incidental consideration was given it in other papers, as appears from the reports given in the *Railroad Gazette* of June 21. Inasmuch as nearly all the commercial as well as the railroad operators begin their career in railroad offices, the responsibility of selecting good material falls in the first instance upon the railroad superintendent. Mr. Pope urged that it would be perfectly feasible to establish and enforce a rule that intending students or assistants shall first be examined and reported upon, with a view of finding out something about their character and their adaptability to the business. It appears from a paper read at the same meeting by Mr. Torrey, superintendent of telegraph of the Michigan Central Railroad, that this practice is in force on his road, and, if we are not mistaken, has been ever since the time, now 30 years ago, when M. D. Woodford occupied the same position. The Michigan Central has always been noted for the high standard of efficiency and technical merits of its telegraphic service,—a fact which may be easily accounted for under the circumstances. The great fault in the telegraphic service, both railroad and commercial, is the too prevalent lack of any feeling of responsibility on the part of the operators beyond that of working a certain number of hours per day and getting paid for it. In old times things were very different. On the lines of the Magnetic Telegraph Company and of the New York and Boston Telegraphic Association, and probably others of the pioneer lines 50 years ago, the greatest care was taken in the selection of operators, and they were sworn into office with as much formality as is the president of the United States. This may look to modern eyes, a little absurd, but it was not so. The candidate for telegraphic honors at least had it impressed upon his mind that he was undertaking a serious responsibility, whereas under the present system, or rather lack of system, two-thirds of the telegraphic service of the country is performed by a herd of immature boys and girls, who, however expert they may be in working the apparatus, are as far as possible from having any adequate sense of the importance of the interests confided to their care. It is all wrong, and is a matter which needs to be radically reformed.

Modern Electric-Power Transmission.

One of the most interesting papers read at the recent annual meeting of the electrical engineers at Niagara was that of G. H. Winslow, describing the electric-transmission plant at Pomona, Cal., which is chiefly remarkable for the long distance over which the energy is transported and the high electrical pressure used, in both of which respects it is, as a commercial apparatus, almost unique. It comprises a Pelton water-power plant working under 390 ft. effective head and fitted with a differential governor. The present generators are single-phase alternators of 120 k. w., running at 7,200 alternations, and are two in number. The units of both raising and reducing converters are of 6 k. w. capacity, and are kept cool by immersion in oil. The ratio of transformation is 1000 : 450, so that in a bank of twenty converters the dynamo pressure required to produce 10,000 volts in the line is 1110 volts on open circuit and 1140 under load. There are two independent transmission circuits, each of two No. 7 copper wires. One, 13¾ miles long, supplies Pomona, and the other, 28¾ miles long, supplies San Bernardino. Double-petticoat flint glass insulators are used. The sub-stations are small brick buildings, and the main circuits are connected direct to the reducing converters without switches or other appliances. Stillwell regulators are placed at the sub-stations, instead of at the power-house as in the usual arrangement. The distribution from the sub-stations is similar to that ordinarily used with a 1000-volt alternating dynamo. No attendance is required at the sub-stations, all necessary regulation being effected by the attendant at the power house. The average efficiency of the Pomona circuit is found by test to be about 75 per cent., and an efficiency of over 60 per cent. was attained in an experimental transmission of 100 h. p. to San Bernardino, *via* Pomona,—a distance of 42.5 miles. No interruption of service has occurred since the plant began working at 10,000 volts on February 16, 1893.

Electric Conduit Railways.

In the June number of this magazine some account was given of the conduit system of electrical distribution about to be tried on the Lenox avenue line of the Metropolitan Traction Company in New York city. This is now in operation, with apparently successful results, and illustrated descriptions giving many interesting details of the plant are published in the current technical journals, notably in the *Electrical Engineer* (July 5). In the *Electrical World* (June 22) may be found a partial description of another conduit system recently offered to the public by the Westinghouse Company, which presents some features of apparent superiority. Groups of metallic contact-pins are inserted in the pavement, each 5 in. in diameter and projecting about ½ in. above the surface. These are rubbed by collector-bars attached to the cars, as they pass over them, and, by means of switches placed in switch-boxes set in the pavement, are connected successively with the insulated feeder cables. Each car carries a small storage-battery, and, as the collector bars slide over the contacts, its current comes into play to operate the switches by an electro-magnetic device. Thus only those contacts which are being passed over by the car are at any time in connection with the source of electric supply. The system is not altogether an untried one, it having been in operation for some time in Washington, D. C., but, as now presented, has material improvements in many of its details. Its first cost, though greater than that of the overhead trolley, must be much less than that of such a conduit system as that of the Lenox avenue line, heretofore referred to. Appearances indicate that the advent of a practicable system of underground distribution for street railways will not be much longer a thing of the future.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

32478. Coal Consumption in an Edison Station. Type of 1890 (Elec Eng–June 12.) 300 w.

32539. The Belfast (Ireland) Municipal Electric Station. Ill. (Pro Age–June 15.) 1100 w.

32671. Light and Electrification. Oliver J. Lodge (Sci Am Sup–June 22.) 3000 w.

32689. Boilers of the City Electric Lighting Plant of Detroit, Mich. Ill. (Eng News–June 20.) 700 w.

32731. The Electric Lighting of the Baltic Canal. Ill. Carl Coerper (Elec Wld–June 22.) 2500 w.

32851. A Central Station With Three-Phased Current Generators. Ill. G. H. Zahn (W Elec–June 29.) 1500 w.

*32898. The Robertson Incandescent Lamp. Ill. (*Elec Eng*–June 21.) 2000 w.

*32906. On the Effect of Pressure of the Surrounding Gas on the Temperature of the Crater of an Electric Arc Light. W. E. Wilson (*Elect'n*–June 21.) 1000 w.

*32909. Dependence of the Photo-Electric Current upon the Azimuth and the Angle of Incidence of the Light. J. Elster and H. Geitel (*Elect'n*–June 21.) 1500 w.

*33054. The Blondel Lumen-Meter. Ill. (*Elec Eng*–June 28.) 1100 w.

Power.

32436. Electric Transmission—When It Will Pay in Mill Work (Bos Jour Com–June 8.) 700 w.

32481. A Radical Departure in Dynamo Design, and the First Plant Installed. Ill. (Elec Ind–June.) 1300 w.

†32500. Electric Power Transmission. F. Jarvis Patten (New Sci Rev–April.) 2400 w.

32519. The Maximum Possible Efficiency of Galvanic Batteries. Henry Morton (Elec Age–June 15.) 1000 w.

32697. The Electric Accumulator. Ill. J. B. Stewart (Elec Age–June 22.) 2000 w.

*32721. Economy and Accumulators. Ill. Ed. W. Cowan (*Elect'n*–June 14.) 1100 w.

*32726. The Maximum Possible Efficiency of Galvanic Batteries. Henry Morton (*Elec Rev*–June 14.) 1200 w.

*32728. The Continuous Current Dynamos of F. Balas and L. Couffinhal. Ill. P. Girault (*Elec Eng*–June 14.) 1400 w.

32769. The Maximum Possible Efficiency of Galvanic Batteries. Henry Morton, in Cassier's Mag. (Am Gas Lgt Jour–June 24.) 1100 w.

32784. The Work that Has Been Done at Niagara. Ill. (Elec Eng–June 26.) 2500 w.

32833. Storage Batteries. C. F. Annett (Elec Age–June 29.) 900 w.

32840. The Testing of Alternating-Current Dynamos. H. Behn-Eschenburg (Elec Wld–June 29.) 2000 w.

32842. Polyphase Currents and Motors (Elec Wld–June 29.) 1800 w.

*32908. Polyphase Motor Calculations. Hermann Cahen (*Elect'n*–June 21.) 2200 w.

*33046. Multiple Current Dynamos. Ill. Rankin Kennedy (*Elec Rev*–June 28.) 1200 w.

*33053. Rotary-Current and Alternating-Current Dynamos of the Algemeine Electricitats-Gesellschaft. Ill. M. Von Dolivo-Dobrowolsky (*Elec Eng*–June 28.) 1700 w.

Telephony and Telegraphy.

32479. Municipal Telephony. Editorial (Elec Eng–June 12.) 2000 w.

32482. An Historic Sketch of the Atlantic Cable. Frank Hallenbeck (Elec Ind–June.) 800 w.

†32495. The World's Cables. Moses P. Handy (New Sci Rev–Jan.) 3800 w.

32509. Telephone Service: The Relative Cost to the User. Fred De Land (Elec Engng–June.) 3300 w.

32654. Reis's Place in Telephony. A. E. Dolbear (Elec Eng–June 19.) 1200 w.

32679. The Projectors of the Atlantic Cable. Abstract of Speech by Chauncey M. Depew (Elec Rev–June 19.) 1500 w.

32681. Opinion of the United States Circuit Court of Appeals in the Berliner Case (Elec Rev–June 19.) 16000 w.

32834. Remedies for Disturbing or Interfering Currents on Telegraph and Telephone Circuits. Thomas D. Lockwood (Elec Age–June 29.) 2000 w.

32860. Modern Telephone Exchange Systems. Ill. George P. Low (Elec Jour–July.) 13500 w.

Miscellany.

32461. Study of Earth Currents. L. Palmieri (Elec Rev–June 12.) 900 w.

†32494. "What Electricity Is." I. Compiled by Mrs. Bloomfield Moore. II. C. J. Reed. III. Henry Clay (New Sci Rev–Jan.) 8000 w.

†32496. Pre-Scientific Electricity. Horace Hayden, Jr. (New Sci Rev–Jan.) 4000 w.

32522. On the Theory of Units. Townsend Wolcott (Elec Wld–June 15.) 2500 w.

32524. The Output of Polyphase Generators and Rotary Transformers. Ralph D. Mershon (Elec Wld–June 15.) 2800 w.

32525. Some Work on Magnetic Hysteresis. Ill. Frank Holden (Elec Wld–June 15.) 1000 w.

*32548. A 30000 Volt Transformer. H. P. Plumb (Sib Jour Eng–June.) 700 w.

*32549. Hysteresis Due to Magnetic Rotation. Floyd G. Ten Broeck and H. F. Schoenborn, Jr. (Sib Jour Eng–June.) 900 w.

*32551. Insulating Properties of Oils. A. C. Bell (Sib Jour Eng–June.) 2000 w.

*32576. Ozone and Nitrous Compounds. E. Andreoli (*Elec Rev*-June 7.) 900 w.

*32591. The Effects of Lightning Discharges on Underground Cables. Ill. C. S. Du Riche Preller (*Elect'n*-June 7.) 2000 w.

*32592. On the Resistance of Galvanic Elements. Dr. Paul Schoop (*Elect'n*-June 7.) 1000 w.

*32594. Electric Discharge Through Gases. Ill. J. J. Thomson (*Elect'n*-June 7.) 3400 w.

*32595. The Electrical Measurement of Starlight. G. M. Minchin (*Elect'n*-June 7.) 1500 w.

*32600. The Electrical Laboratory of the City of London Commission of Sewers. Ill. (*Elec Eng*-June 7.) 2000 w.

*32601. The Magnetic Survey of the United Kingdom. A. W. Rucker (*Elec Eng*-June 7.) 1700 w.

*32602. Some Physiological Effects Experienced in Contact with Live Alternating Current Circuits. Ludwig Gutmann, in Electric Power (*Elec Eng*-June 7.) 1500 w.

†32631. Tests of a Combined Electric Light and Electric Railway Station. Dugald C. Jackson and Arthur W. Richter (Am Soc Mech Eng -June.) 3000 w.

32655. The Interior Conduit and Insulation Company: Its Products and Manufacturing Methods. Ill. (Elec Eng-June 19) 6500 w.

32678. The Three-Wire System—No Longer Necessary. Ill. (Elec-June 19.) 1800 w.

32838. Dimensional Formulæ and the Theory of Units. R. A. Fessenden (Elec Wld-June 29.) 2200 w.

32853. Popular Errors About Electricity. C. C. Haskins (W Elec-June 29.) 1400 w.

32861. The Efficiencies of Electric Plants. Sydney Sprout (Elec Jour-July.) 700 w.

32862. On the Field of Operations of an Electrical Engineer. E. J. Molera (Elec Jour-July.) 4000 w.

*32917. The Clark Cell When Producing a Current. S. Skinner (*Elec Rev*-June 21.) 800 w.

*33042. Safety Regulations for Large Installations. Proposed by the German Electrotechnical Societies. (*Elec Rev*-June 28.) 1400 w.

*33045. On the Variation in Capacity of an Electrostatic Voltmeter. Albert Campbell (*Elec Rev*-June 28.) 800 w.

*33065. The Electro-Chemical Reactions in Secondary Cells. W. R. Cooper (*Elect'n*-June 28.) 1200 w.

*33069. A New Method of Measuring Specific Inductive Capacity. Albert Nodon (*Elec'n* -June 28.) 700 w.

Serials.

6515. Notes on Submarine Cable Work. H. D. Wilkinson (*Elect'n*-Began Sept. 2, 1892—19 parts to date—30 cts. each).

22131. The Incandescence Lamp. A. Bainville (*Elec Rev*-Began May 11, 1894—10 parts to date—30 cts. each).

23866. Electrodynamic Machinery. Edwin J. Houston and A. E. Kennelly (Elec Wld-Began July 21, 1894—39 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (Elec Age-Began Aug. 25, 1894—32 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (*Elec*-Began Oct. 5, 1894—39 parts to date—30 cts. each).

27371. The Electric Light. Henry Stooke (*Ill Car & Build*-Began Nov. 23, 1894—42 parts to date—30 cts. each).

29158. The Construction and Use of Electrical Measuring Instruments. Charles H. Yeaman (*Elec*-Began Feb. 1—19 parts to date—30 cts. each).

30872. Telephony. Ill. V. Weitlisbach (Elec Engng-Began April—3 parts to date—15 cts. each).

31284. Electric Lighting of Trains. Ill. R. W. Weekes (*Elec Eng*-Began April 19—Ended June 28—5 parts—30 cts. each).

31344. Practical Telephony. Ill. James Bell and S. Wilson (*Elec*-Began April 19—11 parts to date—30 cts. each).

31586. Factory Practice in the Design and Construction of Dynamos. Ill. C. E. Woods (Elec Ind-Began May—2 parts to date—15 cts. each).

32038. Nikola Tesla and His Work. Anon. (*Ill Car & Build*-Began May 17—3 parts to date—30 cts. each).

32164. The Shops of the Westinghouse Electric and Manufacturing Company. Ill. (Eng Rec-Began June 1—2 parts to date—15 cts. each).

32463. The People's Lamp. Frank Parsons (Arena-Began June—1 part to date—45 cts).

32603. The Mechanical Principles of Electrical Engineering. H. B. Ransom (*Elec Eng*-Began June 7—Ended June 14—2 parts—30 cts. each).

32723. The Absolute Measurement of Electrical Resistance. J. V. Jones (*Elect'n*-Began June 14—Ended June 21—2 parts—30 cts. each).

32732. The Westinghouse Electric and Manufacturing Company's New Plant. Ill. (Elec Wld-Began June 22—2 parts to date—15 cts. each).

32783. The Shunt vs. the Differential Arc Lamp. E. R. Knowles (*Elec Eng*-Began June 26—1 part to date—30 cts).

32905. Wave Form Synthesis. James Mark Barr, Stanley Beeton, C. Percy Taylor (*Elect'n*-Began June 21—Ended June 28—2 parts—30 cts. each).

32918. The Theory of Three-phase Generators. Arthur Whitwell (*Elec Rev*-Began June 21—Ended June 2—2 parts—30 cts. each).

33066. Notes on Some Experiments with Electro-Magnetic Mechanism. P. V. McMahon (*Elect'n*-Began June 28—1 part to date—30 cts).

33067. Gas Engine Electric Supply Stations (*Elect'n*-Began June 28—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY

How Free Silver Would Affect the United States.

THE perils that would threaten the United States were the advocates of free silver coinage to prevail are set forth clearly and tersely in a paper by Hon. Edward O. Leach, late director of the mint, in *The North American Review* for July. "The free coinage of silver under present conditions . . . . may be defined as the right of anyone to deposit silver of any kind at a mint of the United States, and have every 371¼ grains of pure silver (now worth in its uncoined state about 52 cents) stamped, free of charge, 'One Dollar,' which dollar shall be full legal-tender at its face value in the payment of debts and obligations of all kinds, public and private, in the United States."

The national dishonesty which such an act would involve at this time is then dealt with incisively. The first coinage act (1792) "aimed to approximate the commercial value" of silver and gold. Hamilton held the view that there could scarcely be a better rule than that legal values of the metals should approximate their market values. Jefferson held the same view. "In point of honesty there is no practical difference between stamping and issuing a coin with full debt-paying qualities as $1 which is really worth only 50 cents, and cutting a dollar in half and requiring every one to accept the half as a dollar."

But, passing the dishonesty of such an act, the immediate effect of it would be "to place our currency on a silver basis." Even leading advocates of free silver coinage now admit this. First there would be "a violent contraction of the currency by the withdrawal of gold coins and gold certificates from circulation. The stock of metallic and paper money in the United States is about $2,209,000,000, every dollar of which, under present standard, is as good as a gold dollar and practically interchangeable with gold. The law makes it the imperative duty of the secretary of the treasury to 'maintain the two metals on a parity with each other' and provides the necessary means to accomplish it,—the pledge of the public credit. With free silver coinage the obligation, both moral and legal, upon the government to 'maintain the two metals on a parity' would end. The immediate result would be the destruction of the parity, the separation of our currency between gold and silver, and the withdrawal of $676,000,000 of gold from circulation and use as money. This enormous contraction of the money which is the basis of our currency system would unsettle business, impair credits, destroy values, and produce the most tremendous financial disturbance which this country has ever witnessed.

"After the first shock, the effects of which no man can fully foresee, when values had adjusted themselves to existing conditions, a silver basis means that the paying power of our money in foreign exchanges would be depreciated to the commercial value of the silver in our dollars, whatever that may be. We have a perfect illustration close at hand in our near neighbor, Mexico, of a country on a settled silver basis, with unrestricted gold and silver coinage. The Mexican dollar, although it contains more silver than our dollar, has a purchasing power in foreign exchanges equal only to its commercial value as a bullion. The same is true of the currency of every country which is on a silver basis. There is no country in the world to day where silver is minted into legal-tender coins where gold circulates as money. The commercial relations between European countries and our own are more intimate to-day than were the relations between the States of the Union prior to the civil war. All Europe has practically the gold standard, and all international exchanges, whether with gold-standard or silver-standard countries, are settled on a gold basis. The great bulk of the foreign commerce of the United States is with countries having the gold standard. During the last fiscal year we exported to Europe merchandise of the value of $700,000,000, while we imported from the same countries merchandise of the value of $295,000,000. Between countries which use the same metal as money there is a par of exchange which varies only within well-defined limits, regulated by the balance of trade. Between countries which use different metals as a measure of value there is at present no natural par, because of the fluctuations in the commercial value of the silver. Stability in the rates of exchange is of the very essence of commercial transactions, especially commercial transactions based on credit. Without this there is necessarily an uncertainty which it is impossible to eliminate, and which complicates and deters business transactions. In this lies the *permanent evil of a* silver basis for our money,—*the uncertainty and fluctuations in the value of our currency as measured by the world's standard, gold.* What the purchasing power of our currency in domestic transactions would be would depend upon conditions which no one can foresee or accurately forecast." Thus the United States would become "the dumping-ground of the world's silver." What would we gain? "If we should exchange our stock of gold for a stock of silver, cut loose from the standard of all the great commercial countries with whom we do business, and ally ourselves to Asiatic and South American monetary systems, what would we gain? One of two things would most certainly occur; either our gold would be hoarded by banks, trust companies, and individuals, or else would go abroad to pay for the silver shipped here for sale. In either case our currency would be depreciated and fluctuating in value to the embarrassment of business and the ultimate injury of the wage-earner. The basis of our currency would be changed from gold to silver, but whether the increase in the value of money—the panacea for all our industrial ills promised by free-silver advocates—would be considerable, or the price of silver be permanently increased, is open to serious doubt. Just as long as it was profitable to ship silver to the United States,—that is, just as long as it would bring a higher price here than elsewhere,—silver would come, but it would not come when the shipment ceased to be profitable. If silver ceased to come here because it was not profitable to ship it and receive payment in dollars whose purchasing power was only equal to the commercial value of the metal contained in them, where would be the gain in the volume of our currency?"

The assertion that the decline in prices of wheat, cotton, and other products is due to the disuse of silver as money is completely answered and its absurdity demonstrated. "The decline in the prices of staples could not have arisen from any scarcity of metallic money, for the reason that there is nearly double the amount of metallic money in use in the world to-day that there was in 1860,—the official estimates of the coin stocks being $3,400,000,000 in 1860 against $8,021,000,000 in 1894 (Report of director of the mint, 1894, pages 44–55). Nor could it have arisen from disuse of silver money, for the reason that there is more silver in use in the world now than the entire stock of metallic money in 1860,—the figures for silver money being $4,055,000,000,000 in 1894 against a total metallic stock in 1860 of $3,400,000,000.

"In our own country, where prices have declined as much as elsewhere, it is a fact shown by treasury statements that we have not only more money in actual circulation than ever before, not excepting the flush times of the war, but vastly more silver money . . . . Indeed, there is no country where the amount of actual money has diminished in recent years, but, on the contrary, in addition to an increased stock of metallic and paper money, the effort of civilization and one of its most beneficial results, developed largely during the last 20 years, has been to minimize the use of actual money by providing substitutes in the shape of checks, drafts, bills of exchange, telegraphic transfers, and clearing-house settlements."

"It is sufficient to say that there is not one of the great staple commodities which has fallen largely in price where such decline cannot be readily traced to circumstances affecting the demand and the supply of the article itself."

Free silver coinage "would replace the doubt of our ability to maintain gold payments by the certainty that we did not intend to. It would be a national disgrace as well as a national misfortune—which the people of this country will never submit to—to debase the money of this proud and prosperous republic to the standard of Mexico, South America, and Asiatic countries."

The Precious Metals — Appreciation and Depreciation.

THE above is the title of an article in *The Banker's Magazine* for June, by Mr. Edward Atkinson, which is in the nature of a criticism upon the use of terms employed in recent discussions of monometallism and bimetallism. Mr. Atkinson states that "in the discussion of the monetary question" the words "appreciation" and "depreciation" are used with reference to both gold and silver. This, he thinks, leads to confusion in thought.

"It is held, even by some of the most conspicuous authorities among those who desire that the gold standard shall be maintained, that gold has appreciated in recent years. It is proved that a lessening quantity of gold will command an increasing quantity of products, and that this fact proves appreciation. In this view no regard is paid to the changed conditions under which these products are made and distributed. It follows that, if the product had not increased in ratio to the labor employed, the inevitable consequence of this appreciation of gold would be to render the payment of all national debts and of all other long-deferred payments more and more onerous. It would render it necessary for railways and other corporations which had issued bonds payable at a long-deferred period to do more work at an increasing relative cost and at a lessening price, in order to meet the interest on the bonds and to pay the principal. The announcement of this view by prominent men who are known as monometallists has given to the advocates of what is called bimetallism one of the strongest levers with which to move public opinion.

"On the other hand, the most common, potent, and plausible theory which is put forward by the advocates of the so-called bimetallic policy is that silver has maintained about an even ratio with other commodities in relation to gold, that gold has become scarce and has appreciated to the injury of all who are indebted, and to the great disturbance of commerce."

A criticism of another common expression, "fatal fall in prices," which President E. B. Andrews of Brown University has rendered conspicuous, is also made. "This problem of appreciation or depreciation is one of the most difficult to analyze, and is one which it is almost impossible to put into statistical form. We may deal, however, with any of the accepted tables of the average wholesale prices of all important articles, as in Wright's 'Prices and Wages,' or of selected commodities, as in Sauerbeck's tables, of which the accuracy is admitted by all. We then unquestionably find that there has been a large reduction in the average of prices of most of the necessaries and comforts of life since 1873. On that ground it is urged that gold has become relatively scarce, that it has appreciated, and that hardships have ensued therefrom." Without making extended excerpts from the arguments made to substantiate the proposition that gold has not appreciated, but that products in general have depreciated, in price, we may state that through this line of reasoning the conclusion is reached that "no mere comparison of the prices of goods proves anything as to the relative abundance or scarcity of gold." As to the term "fatal fall in prices," in cotton and wheat, the two staples supposed by the school represented by Prof. Andrews to have suffered most by "the parting of the bullion value of silver and gold," Mr. Atkinson holds that "the burden of proof rests upon those who put forward the idea of 'a fatal fall in prices' to explain how it is that the disaster which they impute to producers has been consistent with the greatest progress ever made in developing production and commerce in these two great staples."

One of the reasons assigned for the confusion of ideas is "that the elementary principle—that the money itself is not the object of an exchange of goods for money, but, rather, what money will buy—is almost wholly wanting in the public mind and in the every-day discussions of the money question."

A Piece-Rate System.

THE title might at first seem to indicate that this review ought to be relegated to the department of mechanical engineering, but, as the subject is treated as "a step toward a partial solution of the labor problem," by Mr. Fred. W. Taylor, in a paper presented at the June meeting of the American Society of Mechanical Engineers, it seems to have an intimate relation with the general trend of current discussion in industrial sociology. The paper describes a system of management introduced by its author in the works of the Midvale Steel Company, of Philadelphia, and which, having been tested for a period of 10 years, is claimed to have been most satisfactory.

In introducing this description, Mr. Taylor alleges that the "ordinary piece-work system involves a permanent antagonism between employers and men, and a certainty of punishment for each workman who reaches a high rate of efficiency. The demoralizing effect of this is most serious. Under it even the best workmen are forced continually to act the part of hypocrites, to hold their own in the struggle against the encroachments of their employers.

"The system introduced by the writer, however, is directly the opposite, both in theory and its results. It makes each workman's interests the same as that of his employer, pays a premium for high efficiency, and soon convinces each man that it is for his permanent advantage to turn out each day the best quality and maximum quantity of work.

"The system consists of three principal elements: (1) An elementary rate-fixing department. (2) The differential rate system of piece-work. (3) What the author believes to be the best method of managing men who work by the day.

"Elementary rate-fixing differs from other methods of making piece-work prices in that a careful study is made of the time required to do each of the many elementary operations into which the manufacturing of an establishment may be analyzed or divided. These elementary operations are then classified, recorded, and indexed, and, when a piece-work price is wanted for work, the job is first divided into elementary operations, the time required to do each elementary operation is found from the records, and the total time for the job is summed up from these data. While this method seems complicated at the first glance, it is, in fact, far simpler and more effective than the old method of recording the time required to do whole jobs of work, and then, after looking over the records of similar jobs, guessing at the time required for any new piece of work.

"The differential rate system of piece-work consists briefly in offering two different rates for the same job,—a high price per piece, in case the work is finished in the shortest possible time and in perfect condition, and a low price, if it takes a longer time to do the job, or if there are any imperfections in the work. (The high rate should be such that the workmen can earn more per day than is usually paid in similar establishments.) This is directly the opposite of the ordinary plan of piece-work, in which the wages of the workmen are reduced when they increase their productivity.

"The system by which the writer proposes managing the men who are on day-work consists in paying men and not positions. Each man's wages, as far as possible, are fixed according to the skill and energy with which he performs his work, and not according to the position which he fills. Every endeavor is made to stimulate each man's personal ambition. This involves keeping systematic and careful records of the performance of each man, as to his punctuality, attendance, integrity, rapidity, skill, accuracy, and a readjustment from time to time of the wages paid him, in accordance with this record.

"The advantages of this system of management are: first, that the manufactures are produced cheaper under it, while at the same time the workmen earn higher wages than are usually paid; second, since the rate-fixing is done from accurate knowledge instead of more or less by guess-work, the motive for holding back on work, or 'soldiering,' and endeavoring to deceive the employers as to the time required to do the work, is entirely removed, and with it the greatest cause for hard feelings and war between the management and the men; third, since the basis from which piece-work, as well as day-rates, are fixed is that of exact observation, instead of being founded upon accident or deception, as is too frequently the case under ordinary systems, the men are treated with greater uniformity and justice, and respond by doing more and better work; fourth, it is for the common interest of both the management and the men to coöperate in every way, so as to turn out each day the maximum quantity and best quality of work; fifth, the system is rapid, while other systems are slow, in attaining the maximum productivity of each machine and man, and, when this maximum is once reached, it is automatically maintained by the differential rate; sixth, it automatically selects and attracts the best men for each class of work, and it develops many first-class men who would otherwise remain slow or inaccurate, while at the same time it discourages and sifts out men who are incurably lazy or inferior; finally, one of the chief advantages derived from the above effects of the system is that it promotes a most friendly feeling between the men and their employers, and so renders labor unions and strikes unnecessary. There has never been a strike under the differential rate system of piece-work, although it has been in operation for the past 10 years in the steel business, which has been during this period more subject to strikes and labor troubles than almost any other industry.

"In describing the above system of management, the writer has been obliged to refer to other piece-work methods, and to indicate briefly what he believes to be their shortcomings."

This system has seemed so important that we have quoted liberally from the exposition of its general features, as given in the introduction; and we may return to its details in a future review.

Gold Hoards.

THE persistent accumulation of gold in the financial centers of Europe, and the resulting constant increase of bank revenues, is ably commented upon in an editorial in *The Engineering and Mining Journal* (June 8). This accumulation is history repeated; the same thing has occurred in previous panic periods, as the result of abnormal timidity of capital. "The fall in prices of products of all kinds which follows a temporary cessation of demand does not stimulate buying, nor does the cheapness of money at such periods favor investment. The vast majority of men buy goods on a rising, not on a falling, market, and the same rule applies to purchases of securities of all kind. When money must be invested, it is put into property which seems to offer a perfectly safe return, and everything which presents the least risk is neglected. It is this which explains the apparent anomaly of the rise of certain recognized securities—such as British consols, French rentes, United States bonds, and the like—at a time when all other values are falling. The same rule governs in speculative transactions as well as in investments. A speculation for a fall—a "bear" operation—is never popular; nearly all men, including many of those who make speculation their business, prefer to operate for a rise, and it is only a few, who are at once shrewd observers and have the courage to follow their judgment, who are large buyers in panic times, and realize usually enormous profits."

"In addition to the amounts shown in the bank returns, there has been private hoarding of gold on a considerable scale, though it is impossible to estimate with any degree of accuracy its total amount." The increase in public and private stores, however, has been sufficient to absorb the total additions made to the world's stock of gold for several years past, and to make large drafts upon the stores previously existing.

In our own country any accumulations of this kind have been prevented by special causes, the chief of which has been the withdrawal of foreign capital, the result of distrust aroused by the condition of our currency and a widespread fear that our treasury would be unable to maintain its payments in gold,—a fear largely due to our "cheap money" agitators. Other causes might be named, but this is enough.

But the present hoarding exceeds all precedent. The total gold now held in the specie reserves of the Bank of England, Bank of France, Austro-Hungarian Bank, Netherlands Bank, Bank of Spain, Bank of Italy, and Imperial Bank of Russia is $1,089,603,000. The total silver held in these reserves is $480.400,000,—making a grand total of $1,570,003,000. To this must still be added the reserves of the Imperial Bank of Germany in silver and gold, $272,720,000, and that of the Bank of Spain, $22,037,000 in silver and gold, bringing the grand total up to $1,864,760,000.

"In addition to the bank reserves reported, there are other notable gold hoards in existence in Europe. The German government has carefully guarded at Spandau the so-called 'war treasure' of $30,000,000, which is not to be touched except in an emergency. It is poorly represented in circulation by a special issue of notes, but the gold itself is withdrawn from use. The Austrian and Hungarian treasuries at the present time hold about $90,000,000 in gold, accumulated in preparation for the resumption of specie payments. Finally, the Russian government holds a reserve, the actual amount of which is unknown, but is believed in well-informed quarters to be large enough to bring the total of the three great government hoards up to at least $175,000,000." It is thought that this hoarding will be still further increased, but to what extent cannot be predicted. One reason for such a belief is found in the American clamor for free silver.

English Engineering Supremacy Departing.

When English publications themselves admit that the prestige of English engineering industries among those of other nations can no longer be maintained, and cite such proofs as are quoted below from *Industries and Iron* (March 1), it cannot be deemed invidious for an American periodical to reprint these proofs, although our patriotism is not of that violent, exorbitant, and abounding kind which rejoices in the misfortunes of another land. The events which the above-named newspaper cites as significant of the decadence of British engineering industries are as follows:

"For a contract for several hundred wagons for the Cologne Direction of the Prussian State Railways, a Milan firm tendered a lower price than over twenty German firms. The tender is not likely to be accepted, for reasons of State policy, and the work will probably be undertaken by a German firm. The fact, however, remains that competition is taking a wider and wider area."

"For a quantity of bridge material for Egypt no English tender was even submitted, those received being entirely from French and Belgian establishments. In the Norwegian contract for steel rails a Belgian firm took the major portion out of 9000 tons, only 3000 tons coming to this country. More significant still is the fact that the railway commissioners of our own colony of Victoria have recently given a contract for a number of locomotive crank axles, draw and buffer springs, etc., to the value of about £7000, to Krupp's of Essen."

The same paper expresses the fear that instances of this kind might be multiplied, and admits the inability of English engineers to compete with foreigners in British colonies and in the very department of industry in which the country has hitherto been supposed to be preëminent.

Consul J. C. Monaghan, at Chemnitz, in a recent report to the State department regarding the competition between Germany and England in the machinery market, says the Germans are now making a very strong effort to supplant British machinery in foreign countries, particularly in the United States. Mr. Monaghan thinks that despite England's favorable natural advantages, the long time in which she has been selling to this country and the fact that Americans are not inclined to buy much foreign made machinery, there is now and will be for some time a fair market here for certain classes of imported machinery. Among these are rotating presses, protected by patents, for fine illustration purposes, special machines for making beet sugar, cement and safety matches, and also machines in which, because of limited demand in the United States and a limited supply of labor familiar with the construction of such machines, American manufacturers have as yet done nothing. In spite of the import duty, machines may be exported from Europe to the United States at a profit, provided that prices are low enough, delivery is made on time and absolute certainty is guaranteed that, in case of breakage, parts of machines will be supplied from store in the United States.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*32399. The Signs of the Times.—A Forecast of Industrial Activity. Edward Atkinson (Eng Mag–Aug.) 5500 w.

*32407. Business Opportunities in Colombia.—Their Great Number and Variety. Ill. C. F. Caracristi (Eng Mag -Aug.) 3000 w.

32428. Gold Hoards. Editorial (Eng & Min Jour–June 8.) 1400 w.

*32455. The Bimetallic Argument. Herman Schmidt (*Bank Mag*–June.) 3000 w.

*32456. Some Monometallist Arguments. Hartley Withers (*Bank Mag*–June.) 2800 w.

†32462. Monopolism in the City of Churches.—A Review of the Brooklyn Street Railway Strike. G. Emil Richter (Arena–June.) 9500 w.

†32490. The Precious Metals.—Appreciation or Depreciation ? Edward Atkinson (Bank Mag–June.) 4400 w.

†32491. Bimetallism. I. As a Bubble. Henry Dunning McLeod. II. As a "New Way to Pay Old Debts." J. W. Cross (Nineteenth Cent–June.) 7500 w.

32508. Trust and Trade Monopolies. W. Clyde Jones (Elec Engng–June.) 3500 w.

*32585. The Shipping Federation.—Why It Was Formed, and What It Has Done (*Fairplay*–June 7.) 4300 w.

†32617. A Piece-Rate System.—A Step Toward Partial Solution of the Labor Problem. Fred W. Taylor (Am Soc Mech Eng–June.) 9000 w.

†32821. How Free Silver Would Affect Us. Edward O. Leech (N Amer Rev–July.) 2200 w.

†32823. "Coin's Financial School" and Its Censors. W. H. Harvey (N Amer Rev–July.) 3800 w.

*32824. The Industrial Problem of the Pacific Coast. I. C. E. Grunsky. II. George W. Dickie (Jour As Eng Soc–May.) 5000 w.

32830.—$1. The Ethical Basis of Distribution and Its Application to Taxation. T. N. Carver (An Am Acad–July.) 6500 w.

32831.—$1. The "Minimum" Principle in the Tariff of 1828 and Its Recent Revival. S. B. Harding (An Am Acad–July.) 5200 w.

32835. Corporations and the Tyranny of Labor. Editorial on Address of Henry B. Brown (Arch & Build–June 29.) 1200 w.

*32864. Tariff Changes and Customs Regulations. Great Britain and Uruguay. Russia. Norway. Sweden. Germany. France. Belgium. Portugal. Spain. United States. Peru. Mexico. Colombia. British Honduras. Tahiti. China. Persia (*Bd of Tr Jour*–June.) 6500 w.

*32865. "Coin's" Food for the Gullible. J. Lawrence Laughlin (Forum–July.) 4500 w.

*32866. Wall Street and the Credit of the Government. I. Period of Declining Credit. II. The Turn in Affairs. III. Personnel of Some of the Leaders in the Silver and Anti-Silver Fight of 1894–5. IV. The Syndicate. V. The Contract. VI. The Loss of Credit and Its Causes. Ill. Albert C. Stevens (Rev of Rev–July.) 7500 w.

*32964. Demand and Supply. Anon. (Ind'y–July.) 1200 w.

32968. Responsibility of the Public in Railroad Strikes. C. M. Hobbs (Ry Rev–June 29.) 2000 w.

*33004. Lincoln on a Government Bank (Soc Ec–July.) 3800 w.

*33005. Integrity of Economic Literature (Soc Ec–July.) 5000 w.

*33006. Protection and Bimetallism (Soc Ec–July.) 1800 w.

*33007. The War and Labor in Japan (Soc Ec–July.) 1100 w.

*33008. The First Trade-Union Incorporated. Charles Cowley (Soc Ec–July.) 900 w.

33009. Export Trade and How to Secure It. C. D. Mitchell (Tradesman–July 1.) 2000 w.

*33016. A Plea for the Gold Standard. W. R. Harper (Am Mag of Civ–July.) 6200 w.

*33075. The Settlement of Labor Disputes by Conciliation and Arbitration. J. Stephen Jeans (*Ir & Coal Tr Rev*–June 28.) 4000 w.

MARINE ENGINEERING

The Japanese Marine.

PERHAPS nothing indicates more strongly the tremendous strides which Japan has made in civilization than the growth of her military and mercantile marine. At a recent meeting of the Japan Society (London) Dr. Francis Elgar read a most interesting paper on this subject (*Steamship* for June), of which we make the following abstract:

The Japanese navy consists of thirty-three ships of all classes, and forty-one torpedo boats. These are exclusive of the ten ships recently captured from the Chinese. Four of these ships are wooden sailing vessels used as training ships. The others comprise the armor-clad Fuso; three cruisers, with small belts of armor at the water-line; seven fast steel cruisers of modern construction, protected by deck armor; six steel unprotected cruisers; one torpedo gunboat of modern type; and ten composite or wooden sloops and gun vessels. The armor-clad Fuso and two of the belted cruisers Hiyei and Kongo were built nearly 20 years ago, and have only a maximum speed of 13 knots. The other armored cruiser, Chiyoda, and the seven deck-protected cruisers are, however, among the fastest ships afloat. One, the Yoshino, is perhaps the fastest cruiser at present in the world, as she is said to have obtained the speed of 23 knots with forced draught upon trial. Four of the others are said to have maximum trial speeds of 18¾ and 19 knots, and the remaining three a speed of 16 knots. These ships are armed with the most modern Krupp's, Armstrong's, or Canet's guns, and they carry large numbers of quick-firing guns and machine guns in addition to their main armaments, which were very effective against the Chinese ships in the recent war. This was the state of the Japanese navy before the commencement of the late war. It has, however, now been increased by the addition of ten Chinese ships taken at Wei-hai-Wei,—one at the engagement which took place on the 25th July last off the island of Phung-do, when the Kow-shing was sunk, and one small gunboat captured at Neuchwang since the ice broke up. The ten vessels taken at Wei-hai-Wei are the armor-clads Chen-Yuen and Tsi-Yuen, the coast-defence armor-clad Ping-Yuen, the deck-protected cruiser Twang Ting, and six gunboats, known as gunboats of the Alpha-Betta class. These vessels are doubtless more or less damaged, but the armor-clads will certainly be repaired in Japan, and become effective additions to the strength of the Japanese navy. Besides the above vessels, there are three fast cruisers of the most modern type building in Japan, to have a speed of 20 knots, one of which, named the Suma, was recently launched at Yokosuka." Two large battleships are also building in England which will be "much more powerful than any foreign men-of-war in the East, and will rank among the first-class battleships of the world. It will be seen that, when the great battleships building in England, and the three fast cruisers building in Japan, are completed, and when the ships taken from the Chinese have been put into a state of efficiency, the Japanese navy will be one of great power. This power is not likely to diminish. There exists in connection with the Japanese navy all the essential elements of development and progress. It is not a case of acquiring ships, some of which may perish and not be replaced, or which cannot be effectively officered and manned so as to be used to the best advantage. The Japanese government have not merely acquired a large number of ships, but they have also created and developed the means of building ships of the highest class for themselves, and of keeping them in good repair. It is perhaps very imperfectly realized here how much can be and is being done in Japan in modern ship construction.

"The modern mercantile shipping of

Japan is of even more recent growth than the imperial navy, and is not more than 20 years of age. It was the difficulties in the way of despatching an expedition to Formosa in the spring of 1874 that demonstrated to the government of Japan the importance of having a fleet of steamships under their national flag.

"The most remarkable feature of the recent changes in Japanese shipping is its evident permanence, and the elements it contains of rapid development and great future progress. The Japanese have not only obtained a fleet of modern warships, as South American and other non-European governments have done, but they have also acquired with the ships the ideas which are necessary to understand them in all the details of their construction and use, and also how to produce such ships for themselves, and to train officers and men who can use them effectively in action. It is one of the most striking instances in the history of the world of the acquisition and assimilation of knowledge and methods that we would have thought in Europe are altogether foreign to the genius of the people."

Corrosion of Boilers and Steam-Ships.

THE *Steamship* for June has an able article on this subject written by Mr. Wm. C. Ward, and reprinted from *Cassier's Magazine*. From years of patient experiment and observation by Mr. Parker, of the British board of trade, and Mr. Phillips of the Institution of Civil Engineers the following conclusions have been reached. "With steel unprotected and exposed to the action of the weather and sea water, corrosion advances at the rate of 1 in. in depth in 82 years, while under the same conditions for iron the rate is 1 in. in 190 years. When exposed to the weather and fresh water, it is 170 years for steel and 630 years for iron. When always immersed in sea water, the periods are 1 in. in 130 years for steel, and 1 in. in 310 years for iron; and, when always immersed in fresh water, the periods become 600 years for steel and 700 years for iron."

The theories that have been advanced for the more rapid corrosion of steel have been: "(1) Want of homogeneity in the metal; (2) galvanic action between iron and steel, when placed in contact; and (3) galvanic action between the steel and its covering of black oxid. With regard to the first theory, it was stated that local action took place, owing to the unequal diffusion of the manganese. But, with the fact that steel-makers can now produce steel with a practically uniform distribution of the manganese, this theory had to 'go by the board.' The theory that steel is, by means of galvanic action, injuriously affected by iron in contact with it was put forward when steel was in its infancy, and seems to have lasted as long as the blame could be thrown upon the rivets. But, with the introduction of steel rivets and the continuance of the corrosion, this theory was entirely disproved.

"In 1879 Sir Nathaniel Barnaby stated that, when the surface oxid was left on steel plates, its effect on the neighboring bared metal was as strong and continuous as copper would be; and in 1887 Mr. Raylton Dixon gave before the Institute of Naval Architects his experience as to a vessel which had been built some 8 years before, entirely of steel, and which had been greatly corroded. On looking at a portion of the interior plating of the part of the vessel where it had not been coated with paint or anything, you could see the mill scale on it, just as it came from the rolls.

"In 1882 Mr. Farquharson, on behalf of the British admiralty, conducted a number of experiments to test the action of mill scale upon plates. They were exhaustive, and the result was to establish beyond dispute that no pitting occurred in mild steel when freed from mill scale; that the loss of weight from corrosion of clean mild and clean iron did not differ much; and that the action of the mill scale is considerable and continuous, like that of a similar quantity of copper. Since these experiments, the admiralty have never wavered in their practice of causing all their steel plates to be 'pickled' to remove the mill scale, as is done for galvanizing."

Particles of carbon and slag present in metal are fruitful sources of corrosion and pitting. The pickling process removes such particles from the surface, where they are chiefly to be found. The action of protective or anti-corrosion paints, usually compounds of lead and zinc, is asserted to be "extremely limited." Such paints possess little value over ordinary paints, when applied to plates covered with mill-scale. It is therefore recommended to pickle all plates, and to thoroughly clean and dry them before painting, the mill-scale being a potent factor in setting up corrosion when plates are immersed in sea water.

Corrosion in boilers is more rapid than in hulls of vessels, because in the former the chemical reaction is intensified by heat. External corrosion of boilers is mostly due to leakage. Internal corrosion takes place from chemical, electrical, and mechanical action, which sometimes combine to accelerate the injury. General wasting and pitting are caused by chemical and electrical action. These actions may be induced by the lubricants used in the engine finding its way into the boiler; air or oxygen dissolved in the water; the presence of mill-scale, carbon, or oxid of the metal; difference of temperature of the metals; and want of homogeneity in the metal.

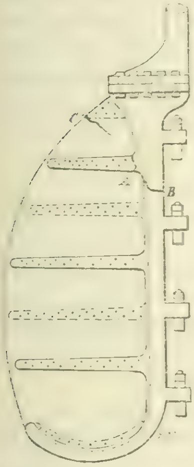
"None but the best mineral oils (pure hydrocarbons), having a high vaporizing point, should be used. Even with mineral oil, after vaporization, a change has taken place. If water be evaporated and condensed, it remains water; but, if oil be evaporated and condensed in the presence of moisture, its nature is changed. True, it retains its greasy nature, but it has become oxidized, and on condensation will appear as a slimy emulsion.

"Bad oils, there is no doubt, have frequently caused pitting, wherever they have settled upon the heated parts; and, to prevent the introduction of oil into the boiler, many engineers have adopted the use of sponge or other feed-water filters to extract or retain the oil from the feed water, while others have discontinued the use of internal lubricants altogether. Many of the Clyde and Tyne firms in Scotland are building engines in which no internal lubrication is used. I have seen triple-expansion engines of 5000 h. p. which have run for years without injury; and, whenever I have had opportunity, I have removed or closed all internal lubricators, and have seen nothing but good effects follow. The oil is evaporated before it reaches the cylinder, and goes into the boiler in a condensed state, without having done any good to the engines. A great deal of trouble is caused by air, either dissolved or free, in the boiler. The troublesome matter is, of course, the oxygen in the air. This, forming oxids, is powerfully aided by the exciting saline constituents of sea water to produce galvanic action, and thus destroy the metal."

The serious and dangerous pitting observable on sides of furnace tubes results from the same action intensified by heat. Pitting is occasioned by the same causes that induce general corrosion, but these are intensified by two other influences, which render the corrosion local instead of general. The influences are rust, mill scale, or other impurity, and variation of temperature. Rust and iron scale are generally in the form of magnetic oxid of iron; and, when the metal of the boiler is acted on chemically by the sea water while in intimate contact with this oxid, the oxid and the metal in its immediate vicinity constitute a voltaic couple. The metallic iron or steel, being the most readily acted on, become the corroded or positive element. This couple induces a current of electricity, having only a very local influence, thus concentrating the action on that limited portion of the iron or steel which has become positive through the influence of the oxid or scale, instead of allowing that action to spread itself generally over a large area.

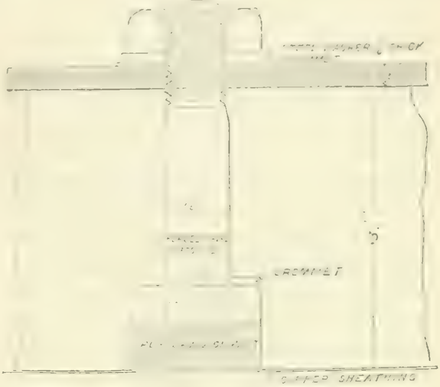
The Broken Rudder of the St. Louis.

THE cut illustrating the break in the rudder of this new and splendid steamer is reproduced from *The Engineering Record*. The ship arrived at New York on June 22, completing her first return voyage. The break was discovered when 3 days out from Southampton, and thereafter the vessel was steered by her engines, —an excellent illustration of the wisdom of not relying solely upon the rudder of a large steamship for directing its course. Notwithstanding her mishap, the steamer made the voyage in 7 days and a little over 7 hours.



The cut shows the rudder exactly as it appeared the day after the ship reached New York. "The rudder is made up of an outer frame of forged wrought iron, extending under the keel and having arms extending from it in the after direction, the arms being alternately riveted to the blade of the rudder at opposite sides, as shown by the dotted line. This blade is one sheet of steel, about 1 in. in thickness. At the forward side the blade sets into a groove in the main part of the frame, and the method of attachment between blade and frame is shown by the rivets. On the forward side of the frame are attached the four pintles. The rudder is attached to its head by a flange joint, as shown, there being a tongue and a groove in the longer direction to re-enforce the bolts. Evidently the initial break took place at *A*. The frame is broken entirely through at this point in a long scarfing break; being lowest at this point at the starboard side and extending diagonally upwards and across so as to be nearly 2 ft. 6 in. higher on the port side of the rudder. A piece is also broken out of the scarf, from 12 to 14 in. long, that seems unaccountable in a wrought-iron or steel frame. The break at this point looks like what would take place in a metal of no ductility, like certain grades of brass. The break at *B* undoubtedly next followed, as all the torsion of the blade then came on that arm. A crack has also started across the plate at *C*, which would undoubtedly soon have worked across to the point *B*. The cross-section of the metal at the point *A* was about 12 × 14 in." The vessel was not delayed in port by the necessity of repairs, as the rudder of her sister-ship, the *St. Paul*, was substituted for the broken one.

Wood and Copper Sheathing for Steel Ships.



In a paper read at the summer meeting of the thirty-sixth session of the Institution of Naval Architects, June 11 (*The Engineer*, June 14), Sir William White discussed the various methods and materials now in use for sheathing vessels, and described, among others, a system which has been applied to the English battleships Centurion, Barfleur, and Renown, and also to a number of cruisers, and which has so far proved completely successful in preventing galvanic action between the copper and iron or steel hulls.

The cut illustrates the system, in which "a single thickness of wood-planking is fastened to the skin plating with bolts of naval brass screwed through the steel skin, with nuts hove up on iron or steel plate washers and gromets on the inside of the bottom plating. The features of the system are: (1) The adoption of such a thickness of wood sheathing as will admit of thorough caulking. The mean finished thickness of teak accepted is 4-in. for large ships and 3½-in. for the smaller classes. (2) The use of naval brass bolts and nuts, with their points screwed through the skin plating, and with thin plate washers fitted underneath the nuts. (3) The thorough water testing of the skin plating before planking is worked. (4) The most careful fitting, fairing, and fastening of the planks; the coating of all faying surfaces with suitable compositions before the planks are fixed in place; and the subsequent injection of composition in order to fill any interstices left between the planking and the plating. (5) The use of hempen gromets steeped in red lead under the bolt heads and under the plate washers, to secure watertightness in the bolt holes.

The Volume of Ships.

AT the recent Paris meeting of the Institution of Naval Architects, Lord Brassey presiding, a paper was read by M. V. Daymard, discussing the utility of making the calculations of the total external volume of ships, and of drawing out the complete scale of solidity, from the triple point of view of tonnage laws, stability, and load line. *Engineering* (June 21), in reporting upon this paper, says that "the author, in view of the confusion that exists from the great divergences in tonnage rules, proposes to solve the problem by considering the whole external volume of ships." The author claims that this unification of tonnage rules, while it would tend to bring about a uniform system, would entail upon no one any heavier dues than are now imposed.

The paper brought out an interesting discussion, the speakers complimenting M. Daymard upon his attempts to solve this difficult problem. It was said that, if it could be done satisfactorily, the author would be entitled to the gratitude of dock companies and ship-owners. All agreed that uniformity of tonnage rules was desirable, but the consensus of opinion appeared to be that the method proposed would not be adopted. In closing the discussion, the author stated that his purpose was more to suggest general principles than to propose a method in the expectation that it would be adopted as a whole.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*32405. Robert Fulton and His Steamboats.—Some Unpublished Historical Facts. Ill. T. C. Purdy (Eng Mag–Aug.) 2500 w.

*32406. James Rumsey, Steamboat Inventor.—The Predecessor of Fulton. Ill. James Weir, Jr. (Eng Mag–Aug.) 2000 w.

*32423. Corrosion of Boilers and Steamships. William C. Ward, in Cassier's Magazine (*Steamship*–June.) 4200 w.

*32424. Dr. Francis Elgar on Japanese Shipping (*Steamship*–June.) 2100 w.

*32425. The Combustion of Fuel. G. F. W. Bapty (*Steamship*–June.) 1800 w.

†32498. Where the Steamboat was Born. Maggie Symington (New Sci Rev–April.) 1700 w.

32523. Electricity on the "St. Louis." Ill. (Elec Wld–June 15.) 2000 w.

32537. Marine Propulsion by Gas-Power. Ill. (Pro Age–June 15.) 1800 w.

32674. Fire Boat for the City of Boston. Ill. (Am Mach–June 20.) 1500 w.

*32709. The New American Trans-Atlantic Steamers. Editorial (*Engng*–June 14.) 1900 w.

*32712. On Wood and Copper Sheathing for Steel Ships. William White (*Eng*–June 14.) 1600 w.

32854. The Broken Rudder of the American Line Steamship "St. Louis." Ill. (Eng Rec–June 29.) 400 w.

*32897. The Port of Auckland. Ill. (*Trans*–June 21.) 1800 w.

32975. The "St. Louis." Ill. (Am Mach–July 4.) 600 w.

*33050. The Cost of Warships (Abstract.) Francis Elgar (*Ind & Ir*–June 28.) 5500 w.

Serials.

21969. The Shark and the Sailor. A. Ewbank (*Ind Engng*–Began April 14, 1894—24 parts to date—45 cts. each).

31117. Traction of Boats on Inland Waterways. W. H. Wheeler (*Eng*–Began April 12—2 parts to date—30 cts. each).

32208. The New British Cruiser "Terrible." Ill. (*Engng*–Began May 24—Ended June 28—4 parts—30 cts each.

32353. Breakdowns at Sea. Ill. W. Welbury (Eng–Began May 31—Ended June 14—2 parts—30 cts. each).

32577. Light-Draught River Steamers. George Rickard (*Ind & Ir*–Began June 7—Ended June 21—2 parts—30 cts. each).

32680. Electricity for Marine Propulsion. W. F. Durand, in Cassier's Magazine. (Elec Rev–Began June 19—Ended June 26—2 parts—15 cts. each).

32880. The Machinery of the American Liner "St. Louis" (Engng–Began June 21—Ended June 28—2 parts—30 cts. each).

32886. Marine Engineering and Shipbuilding on the Thames (*Eng*–Began June 21—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Calorimetric Tests of Steam.

MANY vagaries that have manifested themselves in calorimetric tests of steam in trials of evaporative capacity of steam boilers may probably be accounted for by the peculiar way in which suspended water is distributed in the steam pipes from which the steam is drawn for making the tests. It has long been suspected that some action not understood, taking place in a steam pipe conveying live steam, was one of the causes of the curious results sometimes reached. An important paper on the subject read before the June meeting of the American Society of Mechanical Engineers, by Prof. D. S. Jacobus, refers to late experiments of Prof. Denton, with small throttling calorimeters, results of which indicated "that various calorimeter nozzles, such as are now used in practice, do not give an average sample of the steam flowing through the steam main." The paper deals specifically with a calorimeter nozzle devised by Prof. Denton, which has demonstrated the fact that suspended water in steam flowing through a pipe is very unequally distributed throughout the steam, for the most part flowing near the bottom of a horizontal or inclined pipe, and probably in a small stream nearly parallel with the axis of the pipe.

We have reproduced the drawing accompanying the paper, which illustrates Prof. Denton's apparatus and the action referred to. The nozzle used "consists of a ½-in. pipe, passing through a stuffing-box and so arranged that it may be moved to any position across the pipe under full head of steam."

The tests made with this apparatus indicated that a greater part of the moisture was near the bottom of a horizontal pipe, and that it probably ran along in a small stream. If this was true, then an opening in the bottom of the pipe, so arranged that the water could run freely into it, would glean off all, or the greater part, of the moisture. The tests which are the subjects of this paper were made to determine to what extent such an action takes place, and are a continuation of the preliminary investigation above referred to.

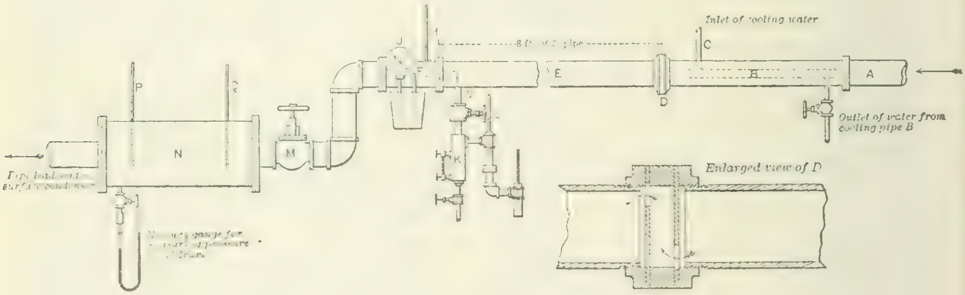
It was found that, after steam had passed through 8 ft. of horizontal 3-in. pipe, 95 per cent. of the entrained moisture, or over, could be drawn from a 1-in. pipe leading from the bottom of the 3-in. pipe, for quantities of moisture as high as 8 per cent., and velocities as high as 25 ft. per second.

The moisture was thoroughly mingled with the steam before entering the 3-in. pipe. The apparatus was so arranged that initially the greater part of the moisture was near the top of the pipe, so that it had to fall through the steam during the time taken to travel over the space of 8 ft. The theoretical time required for a body falling freely in space to travel from the top to the bottom of the pipe is about ⅛ sec. Hence, the maximum initial horizontal velocity that such a body could have and reach the bottom in a horizontal space of 8 ft. would be 64 ft. per second.

It appears from the experiments, therefore, that, for the particular set of conditions which existed, 95 per cent. of the moisture can be gleaned from the bottom of a pipe, if the velocity of the steam is ⅜ that corresponding to the theoretical velocity already mentioned. For a velocity of 20 ft. per second, or about ⅓ the theoretical velocity, 98 per cent. of the moisture was drawn from the bottom of the pipe for quantities of moisture as high as 10 per cent. For a velocity of 43 ft. per second, or 7-10 of the theoretical velocity, about 60 per cent. of the total moisture was drawn from the bottom of the pipe, and at ½ of the theoretical velocity about 90 per cent. was drawn out. It cannot be said that these ratios will apply to all cases, and for this reason additional tests are to be made to determine the effect of increasing the length of the horizontal pipe.

"In Professor Denton's experiments a single calorimeter was at first attached to the bottom of a horizontal 12-in. pipe by means of a nozzle which could be raised and lowered so as to draw steam from various sections of the pipe, as has been already described. It was found that the weight of moisture ranged between about 5 and 50 per cent. of the weight of steam passing through the calorimeter, when the nozzle was lowered so as to be near the bottom of the pipe; whereas, when the nozzle was raised so as to be about 1¾ in. above the bottom of the pipe, the steam which passed through the calorimeter was practically dry. In these tests the steam passed from the boiler through about 10 ft. of horizontal 12-in. pipe to an elbow, and thence through a second horizontal 12-in. pipe. The calorimeter was attached to the second horizontal pipe about 6 ft. from the elbow. The velocity of the steam was about 17 ft. per second, representing about 500 h. p.

"After making the tests with a single calorimeter, a second series of tests was made with two calorimeters, to determine if the moisture was all at the bottom, or if it was also creeping along the sides of the pipe. To make these tests, the second calorimeter was placed at the same cross-section of the pipe as the first, but it was moved to one side, so as to be 4 in. from the calorimeter attached directly to the bottom of the pipe. It was found that, when both nozzles were set so that the ends were flush with the inner surface of the pipe, the calorimeter at the bottom of the pipe indicated successive moisture, whereas the calorimeter 4 in. from it toward the side of the pipe showed practically dry steam. This indicated that all the moisture was at the bottom of the pipe."



DENTON'S CALORIMETER NOZZLE.

The general arrangement of apparatus for conducting the tests on the 3-in. horizontal pipe is represented in the engraving.

"Superheated steam entered at *A*, and passed through a 3-in. pipe surrounding a cooling pipe, *B*. The cooling water entered at *C* and passed off at *G*. After passing the cooling pipe, the steam passed through a device at *D* which thoroughly mixed the steam with the water. This consisted of two plates placed about 1 in. apart, in which were two holes about ⅞ in. in diameter. The hole in the first plate encountered by the steam was at the bottom of the pipe, so that all moisture in the steam would be drawn from the bottom of the pipe. The steam and moisture then passed upward between the plates and out of the hole in the second plate. The hole in the second plate was placed near the top, so as to introduce the steam and moisture near the top of the 3-in. pipe, *E*. The calorimeter was attached at *V*. *K* is the separator portion of the calorimeter, and *L* the heat gage. The temperature and pressure of the steam were measured on leaving the pipe, *E*, by means of the thermometer, *H*, and the pressure gage, *J*. The thermometer, *H*, was placed in a mercury well having an enlargement at its lower end and a thin neck. The steam was throttled by means of the valve, *M*, from a pressure of about 80 lbs. above the atmosphere in the pipe, *E*, to about the pressure of the atmosphere in the 12-in. drum, *N*. The temperature of the steam after throttling was measured by a thermometer, *Q*, placed in a mercury well, and by a thermometer, *P*, which came in direct contact with the steam. The pressure in the drum, *N*, was measured by means of a mercury gage. The steam flowing into the drum, *N*, was led to a surface condenser, and finally weighed.

"The amount of moisture passing through the valve, *M*, was indicated by the amount of superheating in the 12-inch drum, *N*. This moisture, added to the moisture in the steam entering the Barrus calorimeter, gave the total moisture contained in the steam passing through the 3-in. pipe. Corrections, determined directly by experiment, were made for all radiation. The factor of 0.48, for the specific heat of steam, was employed in calculating the percentage of moisture, and special experiments were made to show how nearly this method would agree, in the case of the 12-in. drum, with the experimental normal reading for dry steam. These experiments, from the nature of the apparatus, could be made only with the steam just at the point of superheating, or with slightly superheated steam, and the results obtained were the same as in similar tests made on a Barrus calorimeter, and given in a paper on 'Errors of Calorimeters,' read at the same meeting.

"Three series of these tests were made. In the first there was no mixing device placed at *D*. In these it was found that the thermometer, *H*, would indicate superheating with considerable moisture entering the calorimeter nozzle, *V*. The second series of tests were made after adding the mixing device, *D*. In the third series of tests the 3-in. pipe containing the cooling pipe, *B*, was lowered, together with the mixing device, *D*, and the steam was made to pass through an S-shaped connection of 3-in. pipe into the pipe, *E*. This caused the steam which was admitted to *E* to pass upward through a vertical pipe, then turn through an elbow into the pipe, *E*. The object of the latter arrangement was to make the mixture of steam and water enter the pipe *E* at the same velocity at which it flowed through it. When the steam and moisture entered the 3-in. pipe directly from a 7-in. hole in the mixing device, *D*, it was initially at a much greater velocity than the average velocity in the pipe, *E*; but it was considered best to make tests in this way, so as to have one set of tests in which the conditions were as severe as possible."

In an appendix a tabulated statement of the results of tests is given.

Carrying Capacity of Gas-Pipes.

WE have not before seen this subject presented in so available and convenient a form as in the following excerpt from a pamphlet published by The Norwalk Iron Works Co. and entitled "A Few Facts Concerning Machines for Pumping Natural Gas," which says:

"It is a common idea that the carrying-capacity of a pipe is in proportion to its internal area. This is, however, not correct. A pipe 4 ft. in diameter has only four times the area of a pipe 2 ft. in diameter, and yet the 4-ft. pipe will carry 5.66 times as much fluid as the 2-ft. pipe, under the same conditions of length and head. In other words, a 2-ft. pipe will carry 17.6 per cent. or nearly 18 per cent. as much as will a 4-ft. pipe. This proportion of carrying-capacity does not hold good for smaller pipes of the same proportionate diameter. A 1-ft. pipe has only 16.6 per cent. of the carrying-capacity of a pipe 2 ft. in diameter, and a 1 in. pipe will carry only 14 per cent. as much as a 2-in. pipe.

"These features have not to our knowledge been heretofore taken into consideration in tables prepared for equalizing pipes. The proper values are given in the table below. In this table the commercial or nominal size is given, but in our calculations we figure 1¼-in. pipe as 1.3 in. diameter, and 1½-in. pipe at 1.6 in., as these are nearer the actual sizes.

"The size of pipe is given in the horizontal line on top, and directly beneath is stated successively the proportion of its capacity that other pipes will carry. These other pipes are stated in the vertical column on the left.

"For example, a 6-in. pipe can have 15 per cent. of its capacity carried by a 3-in. pipe, 23 per cent. by a 3½-in. pipe, 34 per cent. by a 4-in. pipe, and a 24-in. pipe will carry 38 times as much as the 6-in. pipe.

"In taking branches from a main it is advisable that the sum of the percentages of the carrying-capacities of the branches should be 100 per cent. or more. Referring again to a 6-in. main, we see that, if it be divided into two branches, one 4 in. and the other 5 in., the carrying-capacities of the branches would be respectively 34 and 63 per cent. of the 6-in. pipe. Thus provision is made for only 97 per cent., and there would be slight additional friction from the point of diversion of the branches. If the branches be made 4½ and 5 in., the percentages are respectively 47 and 63, their sum 110, and, from the junction, the flow would be considerably more free than in the first case."

Relative Carrying Capacity of Pipes for Gas.

	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	10	12	24
1	1.	[illegible]	[illegible]	.14	[illegible]	.05										
1¼	2.1	1.	.55	[illegible]	.16	.10	.06									
1½	3.7	1.8	1.	.53	.29	.18	.11	.08								
2	7.14	[illegible]	1.9	1.	.53	.33	.21	.14	.10							
2½	13.4	[illegible]	3.5	1.9	1.	.63	[illegible]	[illegible]	.20	.15						
3	21.4	10.3	[illegible]	3.	1.6	1.	.67	.43	[illegible]	.23	.15					
3½		16.1	9.	4.7	2.5	1.5	1.	.68	.50	.38	.23	.15				
4			13.1	6.9	3.7	2.3	1.4	1.	.71	[illegible]	[illegible]	.23	.15			
4½				9.6	5.	3.1	2.	1.4	1.	.77	.47	[illegible]	[illegible]	.12		
5					6.7	[illegible]	2.6	1.8	[illegible]	[illegible]	[illegible]	.42	.28	.16	.10	
6						6.5	4.3	2.9	2.1	1.6	1.	.66	[illegible]	[illegible]	.16	.03
7							6.5	4.4	3.2	2.4	1.5	1	.71	.40	.24	.04
8								6.5	[illegible]	[illegible]	[illegible]	1.4	1.	.59	.36	06
10									8.3	6.3	3.9	2.5	1.7	1.	.61	.10
12										10.3	6.3	4.1	2.8	1.6	1.	[illegible]
24											[illegible]	[illegible]	17.3	9.6	6.	1.

Reporting Boiler Tests.

A CRITICISM of the standard code of reporting boiler trials, heretofore employed by the American Society of Mechanical Engineers, was read at the June meeting of the society by F. W. Dean. The question of reporting a boiler trial in such a manner as to show its true value "as a generator of the possible heat in the fuel and as an absorber of the heat generated independent of the quality of the fuel" is dealt with, and the attempt is made to show that the code of the society, if followed, does not, at least in some cases, insure that these determinations will be clearly indicated. The efficiency must be determined and reported. The term efficiency is defined as "the ratio between the heat which any given coal can generate by complete combustion, and that part of it which is absorbed by the water and steam heated and generated." Through the efforts of the society, Mr. Dean hopes to make the public understand the meaning of efficiency.

"This naturally leads to a discussion of the report by a committee of and to this society, recommending a standard method of making and reporting boiler trials, as printed in Volume VI of the 'Transactions.' That report is emphatic in expressing the desirability of a standard method, and particularly of the importance of expressing the value of the boiler. On page 259 the report says: 'The scheme must also be so complete that, if carefully and exactly followed, the precise value of the boiler may be ascertained with certainty.' Yet after this the word 'efficiency' is scarcely mentioned, much less recommended as a measure of value, thus wholly missing the point. Wherever used, it is in the most general sense. In one discussion it appears with its proper signification.

"The report recommends, on pages 262–3, that its standards of power and economy be respectively the 'commercial horsepower' and 'unit of evaporation,' both of which are explained. It then says (page 263) that the relative economy of boilers is expressed by the number of units of evaporation obtained by a pound of combustible. Nothing could be further from the truth. In fact, this conveys only the roughest idea of the relative economy of boilers, and takes no account of the fact that combustible, as well as coal, varies in heat value per pound. In a recent case that came under the writer's notice a pound of combustible contained 14,177 units of heat, and another 15,398. The latter is 8.6 per cent. greater than the former, and therefore ought to evaporate at least 8.6 per cent. more water from and at 212.° If the evaporation per pound of combustible in the two boilers using these coals had been equal, according to our society's code, they would have been equally good boilers. It is evident, however, that they would have been far from equally good. In one case the evaporation was 11.85 lbs., on this basis, while with the better coal in the same boiler it would have been $11.85+1.086=12.87$, thus changing it from a fairly good to be a remarkably good boiler.

"The boiler using the better coal gave a better result than it is in general entitled to, and has apparently misled both its designer and builder, as well as the public, while, if its merits had been judged by its efficiency, it would have taken its proper place as a steam generator."

The comparison of boilers should be made and guarantees should be based on relative efficiency. To this end Mr. Dean submitted to the consideration of the society a new form of blank, which, if adopted, will, he thinks, secure the end sought. Evidently this blank has been carefully thought out. It is too voluminous to be reprinted here. In the discussion following the reading Mr. Geo. H. Barrus, without committing himself or others to the form of blank submitted by Mr. Dean, admitted that the form adopted by the society was behind the times, and that a revision was needed.

Aluminum Alloys.

AS alloys of aluminum are finding increasing use in mechanical construction, every contribution to existing knowledge of the subject is welcome. The principal object of an investigation carried out by Messrs. S. R. Leonard and J. H. Schnepel, an account of which is given in *The Sibley Journal of Engineering* for June, was to determine the value of alloys of this metal with tin. "In addition, considerable work was done with the pure metal, and with some scattering alloys other than those of tin, in the form of bars taken from cold rolled sheets. This mechanical treatment of the metal is of great importance,—more, comparatively, than the alloying with other metals,—while the combination of judicious alloying with effective treatment in the rolls gives remarkable results.

"The material, as received from the Pittsburgh Reduction Co., comprised bar and tension piece castings, and bars sawed from the rolled sheets, of the following grades: 99 per cent. pure aluminum, castings and rolled bars; pure aluminum alloyed with 7 per cent. copper, castings; with 20 per cent. zinc, 3 per cent. copper, 1.3 per cent. manganese, castings; with 2 per cent. and 4 per cent. copper, rolled; with 2 per cent. copper and 1½ per cent. chromium, rolled. Besides these specimens, cast tension pieces were made, containing 2 per cent., 4 per cent., 6 per cent., 8 per cent., and 10 per cent. chemically pure tin."

"The hardness of each alloy was determined. This property is entirely relative, yet may be expressed much more accurately than by the usual method of stating that one specimen will scratch another. In this work the scheme in use for government tests at the Watertown Arsenal was followed. A standard tool was used, and was forced into the metal by a certain load, the reciprocal of the volume displaced being assumed a relative measure of the hardness of the metal. The tool consists of a quadrangular pyramid, with the sides and opposite angles of the base equal, the longest diagonal of which base is 1", the shortest 0.2", the height of the pyramid being 0.1". The indentation made is diamond-shaped, with, of course, a maximum length of 1", width of 0.2", and depth of 0.1"; and the volume displaced is proportional to the cube of the long diameter, the varying lengths of which are easily measured. Al- the data in hardness were taken under a load of 4400 lbs., that being used for similar work at Watertown."

The table herewith gives results obtained from a variety of alloys. Alloys with tin appear to be uniformly weaker than the unalloyed aluminum. Another notable peculiarity is that "the alloys seem to have uniformly greater fibre-strength in the transverse tests.

"All of the cast specimens, whether tin or other alloys, have very poorly defined elastic limits, the stress-strain diagrams departing from the straight line of perfect elasticity from the very beginning. The rolled specimens show a characteristic change in this respect. Within a fairly definite elastic limit their stress-strain diagrams are perfectly straight lines.

"Two of the scattering alloys are of especial interest. One containing 20 per cent. zinc, 3 per cent. copper, and 1.3 per cent. manganese has the greatest ultimate strength of all, but is very hard and brittle. Alloys like this, containing considerable zinc, are especially used to give hardness to other grades with which they are mixed. The specimens containing 2 per cent. copper and 1½ per cent. chromium stand second in strength in the list, showing the marked effect of a very little chromium in hardening and strengthening the metal."

	Character of Group of Specimens.	Strength. Lbs. Per Sq. In.				Modulus of Elasticity. Lbs Per Sq. In.		Ductility, Per Cent In Tension.	Relative Hardness.	Specific Gravity.
		Tension.		Transverse.						
		Elastic	Maximum.	Elastic	Maximum.	Tension.	Transverse.			
Cast.	Aluminum, 99 per cent., pure	4000	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	3.61	2.662
	7 per cent. copper	[illegible]	[illegible]	[illegible]	25250	11,115,000	[illegible]	1.00	12.87	2.820
	20 per cent. zinc 3 per cent. copper 1.3 per cent. manganese		[illegible]		23420	9,685,000	8,060,000	15	35.56	3.081
Rolled.	Aluminum, 99 per cent. pure	[illegible]	[illegible]	[illegible]		9,780,000	10,055,000	8.49	7.03	2.712
	2 per cent. copper	[illegible]	[illegible]	16290		9,505,000	9,965,000	19.49	9.54	2.741
	4 per cent. copper	[illegible]	[illegible]	26590		10,440,000	10,330,000	3.62	12.88	2.774
	2 per cent. copper 1½ per cent. chromium	[illegible]	26310	[illegible]		9,850,000	9,813,000	1.31	14.09	2.759
Cast.	2 per cent. tin	[illegible]	8622			5,435,000		4.00	3.71	2.689
	4 per cent. tin	2400	9565			6,210,000		5.38	3.74	2.738
	6 per cent. tin	2250	9315			5,035,000		5.19	3.49	2.771
	8 per cent. tin	2000	7270			5,175,000		3.06	3.33	2.803
	10 per cent. tin	1750	7352			6,675,000		3.87	3.09	2.856
	Small iron castings								90.9	
	Wrought iron, 1"×¼"								56.4	

Economy in Steam Engineering.

On this subject Mr. George West in *The Stationary Engineer*, makes some timely remarks anent the sweeping assertions of hustling salesmen of machinery of all sorts, steam engines included. He asks what avail is it to incur the expense of replacing a serviceable engine of suitable capacity by one of the latest improved type, which is guaranteed to work on a consumption of a fair percentage less of steam per horse power, if it be no more suited to the situation than the other? A point in this connection which is not clearly explained at the time is that the engine must be worked at a certain load in order to obtain these guaranteed results. Any deviation from this, above or below the rated capacity, will make a difference in the amount of steam required per horse power developed; and unless we can keep it loaded to this point our new engine will give little if any better results than the one which was replaced did when working at its best.

Sometimes a high-class steam engine which has been proven, by the use of the indicator, to require but a small amount of steam for the development of a horsepower, does not prove as economical as expected, and the reason is sometimes difficult to determine. Unsuitable load may be one reason for the lack of efficiency, and another will probably be found in the long line of bare steam-pipe that connects it with the boiler. Some carefully made tests have shown that where the engine is being worked at its rated capacity a loss of energy by radiation of heat and loss of steam by condensation in the pipes and cylinders has amounted to fully forty per cent, of the total amount of water evaporated in the boiler. Many other losses are possible.

In view of these facts does it seem advisable, or business like, to place such machines in charge of persons who do not understand the principles under which they are built, or the details of their construction, simply because it is found that there is a reduction in the one item of wages while at the same time there is an increase in several items of expense.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

32612. Practical Blacksmithing and Tempering. Ill. Isaac Cowen (Sci Mach–June 15.) 1200 w.

†32621. Force Required and Work Performed in Driving and Pulling Cut and Wire Nails. R. C. Carpenter (Am Soc Mech Eng–June.) 600 w.

32672. Cutting Bevel Gears in a Universal Milling Machine. Ill. Jarus (Am Mach–June 20.) 2800 w.

32676. Spacing Holes, etc. James F. Hobart (Am Mach–June 20.) 1200 w.

*32893. Teeth of Machine Saws. Ill. W. Samuel Worssam (*Ind & Ir*–June 21.) 5500 w.

32970. Redrawing of Wrought Iron Tubes. Ill. (Sci Am–July 6.) 800 w.

32972. The Annealing of Armor Plates by Electricity. W. W. Hanscom (Sci Am–July 6.) 1000 w.

32976. Mechanical Calculating Instruments. William Cox (Am Mach–July 4.) 1000 w.

32981. Unnecessary Work. C. R. Tompkins (Age of St–June 29.) 1100 w.

33011. A Modern Machine Shop. J. B. Rich (Tradesman–July 1.) 2000 w.

Steam Engineering.

32435. Burning Small Coal.—A Description of a Traveling Grate for This Purpose. From a paper by Eckley B. Coxe (Bos Jour Com–June 8.) 1100 w.

32477. Longitudinal Expansion of Steam Mains (Ir Age–June 13.) 1800 w.

*32543. The Heat Cycle in the Cylinder Walls. Albert Barnes and H. Zimmerman (Sib Jour Eng–June.) 1500 w.

*32544. Constants for High Speed Engine Design. F. F. Gaines and H. E. Williams (Sib Jour Eng–June.) 1000 w.

*32546. The Heating Values of Coal. E. M. Gilbert and B. P. Flory (Sib Jour Eng–June.) 900 w.

*32547. The Heat Insulating Properties of Different Steam Pipe Coverings. F. J. Emery and J. H. Godfrey (Sib Jour Eng–June.) 1100 w.

*32550. Steam Calorimetry. G. W. Collins and T. T. Hubbard (Sib Jour Eng–June.) 1600 w.

32578. Single-Acting Engines.—Some Points Concerning Their Success in Europe (Bos Jour Com–June 15.) 1100 w.

†32622. The Efficiency of Boilers. A Criticism of the Society's Standard Code of Reporting Boiler Trials. F. W. Dean (Am Soc Mech Eng–June.) 2000 w.

†32624. Tests Made on the Experimental Engine of Sibley College, Cornell University. Ill. R. C. Carpenter (Am Soc Mech Eng–June.) 2500 w.

†32627. The Down-Draught Furnace for Steam Boilers. Ill. William H. Bryan (Am Soc Mech Eng–June.) 5000 w.

†32630. A Method of Proportioning Cylinders for Compound Engines. E. C. Knapp (Am Soc Mech Eng–June.) 1200 w.

†32633. Pipe Covering Tests. Ill. George M. Brill (Am Soc Mech Eng–June.) 3000 w.

†32636. Tests to Show the Distribution of Moisture in Steam When Flowing Through a Horizontal Pipe. D. S. Jacobus (Am Soc Mech Eng–June.) 1800 w.

32761. Water Tube Boilers. Allan Sterling, with Discussion (Can Min Rev–June.) 4700 w.

32813. Something About Steam Gauges. W. H. Wakeman (Safety Valve–June 15.) 1500 w.

32820. The Prevention of Boiler Explosions. Editorial (Eng News–June 27.) 3000 w.

32940. Setting the Valves of a Corliss Engine. Ill. W. H. Wakeman (Mach–July.) 2200 w.

32945. About Chimneys—Some Considerations Necessary to Success (Bos Jour Com–June 29.) 1200 w.

†32955. The Cost of Steam Power. Charles E. Emery (St Ry Jour–July.) 6000 w.

*33058. Draught. E. G. Constantine (*Prac Eng*–June 28.) 1500 w.

Miscellany.

*32403. Is the Inventive Faculty a Myth? A Few Posers for Juries and Mechanics. William H. Smyth (Eng Mag–Aug.) 4000 w.

*32419. Metal Spinning. Ill. Anon. (*Ill Car & Build*–May 31.) 1300 w.

32431. A New Channeling Machine. Ill. (Eng & Min Jour–June 8.) 800 w.

32454. Men and Machinery. J. H. Allen, in Dixie (R'y Rev–June 8.) 2000 w.

32484. Paper Punching. Ill. Oberlin Smith (Am Mach–June 13.) 1700 w.

32485. The Adiabatic for Perfect Gases. G. A. Goodenough (Am Mach–June 13.) 500 w.

32486. Mechanics of Safe Burglary. Ill. H. F. G. (Am Mach–June 13.) 1700 w.

32487. Laying Out Angular Work. Ill. Frank Piers (Am Mach–June 13.) 800 w.

32488. The Evolution of a Crank Disk and Shaft. Ill. H. Hansen (Am Mach–June 13.) 1700 w.

*32545. Investigation of Aluminum Alloys. S. R. Leonard and J. H. Schnepel (Sib Jour Eng–June.) 700 w.

†32620. The T-Square and Its Mountings. Ill. W. A. Gabriel (Am Soc Mech Eng–June.) 500 w.

†32623. The Effect of Length of Specimen on the Percentage of Ductility. R. C. Carpenter (Am Soc Mech Eng-June.) 1000 w.

†32626. New Forms of Friction Brakes. Ill. W. F. M. Goss (Am Soc Mech Eng-June.) 2500 w.

†32628. A New Shaft Governor. Ill. E. J. Armstrong (Am Soc Mech Eng-June.) 500 w.

†32629. A Horse-Power Planimeter. Ill. Edward J. Willis (Am Soc Mech Eng-June.) 500 w.

†32632. Description of a New Form of Sterilizer. A. M. Goodale (Am Soc Mech Eng-June.) 700 w.

†32634. A New Coal Calorimeter. Ill. R. C. Carpenter (Am Soc Mech Eng-June.) 4500 w.

32669 History of Automobile Carriages. Ill. From La Nature (Sci Am-June 22.) 900 w.

32763. Progress in the Cotton Field. Ill. Willard P. Parsons (Mfr & Builder-Jan.) 2600 w.

32804. Napoleon Bonaparte in Egypt, and the Differential Refractometer at the Stevens Institute of Technology. Henry Morton (Sci Am-June 29.) 900 w.

32805. The Faults of the Plow. From La. Planter (Sci Am-June 29.) 1500 w.

32810. The Old and the New. Robert Allison, with Discussion. Presented at Meeting of Am. Soc. of Mech. Eng. (Am Mach-June 27.) 5000 w.

*32879. Road Locomotion. Editorial (*Engng*-June 21.) 1400 w.

*32883. A Great Boiler Explosion. Ill. (*Eng*-June 21.) 1700 w.

*32929. Experiments on the Lubrication of Axle Bearings. E. Chabal (*Prac Eng*-June 21.) 1000 w.

32934. A Reminiscence of the Milling Machine. A. H. Brainard (Mach-July) 1000 w.

32935. Instruments of Precision for the Draughting Room. William Cox (Mach-July.) 600 w.

32938. Strength of Boiler Seams. N. J. Smith (Mach-July.) 1200 w.

32939. About the Inertia Governor. John E. Sweet (Mach-July.) 900 w.

*32967. Some Tests with Fuel Gas, Conducted by the Southern Pacific Company at Sacramento, Cal. Ill. A. J. Treat (Am Eng & RR Jour-July.) 2800 w.

32977. Centrifugal Force. J. Begtrup (Am Mach-July 4.) 1500 w.

32980. Rifling Machines—Theory of Rifling. Payson Burleigh (Age of St-June 29.) 1800 w.

†*33079. Production Up to the Power Limit.—The Destructive Use of Machine Tools. H. L. Arnold (Eng Mag-Aug.) 3000 w.

Serials.

13033. Practical Hints to Boilermakers and Templaters. Ill. (*Mech Wld*-Began May 12, 1893—19 parts to date—30 cts. each).

13534. The Gas Engine. (*Mech Wld*-Began June 2, 1893—16 parts to date—30 cts. each).

16781. Rope Driving. Ill. J. J. Flather (Elec Wld-Began Oct 26, 1893—21 parts to date—15 cts. each).

18044. Motive Power and Gearing. E. Tremlett Carter (*Elect'n*-Began Dec. 1, 1893—36 parts to date—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (*Elec*-Began Aug. 31, 1894—20 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Ill. Theodore F. Scheffler, Jr. (Mach-Began Oct., 1894—10 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (*Mech Wld*-Began Dec. 7, 1894—10 parts to date—30 cts. each).

30216. Care and Maintenance of Machinery. Ill. (Tradesman-Began March 15—7 parts to date—15 cts. each).

30555. The Proportions and Movement of Slide Valves. Ill. W. D. Wansbrough (*Mech Wld*-Began March 22—6 parts to date—30 cts. each).

31365. Boiler-Making. C. E. Fourness (Loc Engng-Began May—3 parts to date—30 cts. each).

31763. Thermo-Dynamics. W. C. Popplewell (*Prac Eng*-Began May 3—5 parts to date—30 cts. each).

32328. Some Thoughts on Machine Design. Ill. De Volson Wood (Am Mach-Began June 6—2 parts to date—15 cts. each).

32390. Modern Economy in Steam Engines. Ill. W. Arnold (*Prac Eng*-Began May 31—Ended June 14—3 parts—30 cts. each).

32434. Reactive Effects of Our Patent System. Otis Kendall Stuart (Eng-Began June 8—2 parts to date—15 cts. each).

32466. Lubricants and Lubrication. From the Textile Recorder (*Prac Eng*-Began June 7—4 parts to date—30 cts. each).

32675. Facts for Young Engineers. W. H. Wakeman (Am Mach-Began June 20—2 parts to date—15 cts. each).

32677. A Modern Machine Shop. Ill. Horace L. Arnold (Am Mach-Began June 20—2 parts to date—15 cts. each.)

32739. Radial Valve Gearing. Ill. H. J. Teiper (Eng-Began June 22—1 part to date—15 cts).

32814. Description and Trials of Todd's Terminal Exhaust Steam Engine (Safety Valve-Began June 15—1 part to date—15 cts).

32923. Core Grids. Ill. Joseph Horner (*Mech Wld*-Began June 21—1 part to date—30 cts)

33012. Five Years Apprenticeship in the Machine Shop. Anon. (Tradesman-Began July 1—1 part to date—15 cts).

MINING & METALLURGY

Explosives for Use in Coal Mines.

At a recent meeting of the Federated Institution of Mining Engineers in London, Mr. Vivian B. Lewes read a paper on mining explosives, the substance of which is given in the *Colliery Guardian* (June 7). The paper is really a monograph of high importance, and in it the author treats his subject especially from the chemical point of view. In reviewing the properties of the various mining explosives now in use, the author, for convenience, classifies them as follows, according to the way in which they produce the gas which gives the explosive effect: (1) Explosion due to simple combustion, as in the case of blasting gunpowder; (2) explosion due to detonation of the whole of the explosive, as in nitroglycerine, nitrocotton, and some Sprengel explosives; (3) explosion due to detonation of part of the explosive, and combustion of the remainder, as in carbonite, westphalite, etc.

As to the first class, gunpowder itself is practically never used, and Mr. Lewes says that "the only word that can be said in favor of the blasting powder is that it is cheap." To this it should be added that in mines other than coal mines, where there is no danger of ignition of inflammable gas or dust, and where a slow, pushing force is needed rather than a sharp, shattering one, the common black blasting powder still holds its own, partly because of its effectiveness and partly because of its cheapness, notwithstanding the danger from premature explosions. But, as Mr. Lewes remarks, it is absolutely unfitted for use in coal mines, and "its abolition would do away with more than three-quarters of the number of deaths caused by explosives." Perhaps it would be better to substitute "a large proportion" in place of the "more than three-quarters" of the text. The great danger consists in the combustible nature of the products evolved during decomposition,—a factor in coal mine explosions which the author thinks cannot be overrated. "On firing a charge of 1½ lbs. of blasting powder, over 3 cu. ft. of combustible gas, chiefly carbon monoxid, would be produced, and this, when mixed with pure air, would give over 10 ft. of an explosive, or, at any rate, rapidly burning mixture; and experiments upon the effects of fire-damp and dust combined show conclusively that, even when fire-damp is present in such minute quantities as to form a mixture very far removed from the point of explosion, it makes the mixture of coal dust and air highly explosive; and traces of carbon monoxid will do exactly the same thing when the air is laden with coal dust." A table is given showing that black blasting powder, taking all the gases as 100, evolves 38.75 per cent. of carbon monoxid, 7.10 per cent. of sulphuretted hydrogen, 2.75 per cent. of marsh gas, and 5.24 per cent. of hydrogen,—all of which mean much flame and consequent danger.

The distinctive characteristic of the explosives of Mr. Lewes's second division is that all the members of it are capable of complete detonation, provided always that the right sort of detonator is used. Nitroglycerine, for example, produces only carbon dioxid, water, nitric oxid and nitrogen,—and no combustible products. It would be the best of all explosives, were it not for the danger inseparable from its physical conditions and sensitiveness to shock. It is, therefore, almost always used with an absorbent (as in dynamite) or in combination (as in blasting gelatine). But "some of the best of the nitroglycerine class, such as blasting gelatine, are among the worst offenders as regards the evolution of combustible products, as the deficiency in oxygen of the nitrocotton is not made up by the excess in the nitroglycerine used." Nitrocotton alone is often used for blasting, but gives a maximum amount of combustible products. Several explosives have been made on the principle of mixing nitrocotton with oxidizing materials, but the only one in use is tonite, in which the generation of carbon monoxid is reduced by the use of mineral nitrates. Such mixtures give a residue of fused salts, which, if blown out into an explosive atmosphere, are liable to cause ignition. Sprengel explosives are now largely used in blasting. They generally consist of mixtures of nitrated hydrocarbons and ammonium nitrate. Roburite is a mixture of the nitrate with nitrobenzol, and is not exploded by ordinary percussion, firing, or electric sparks, but requires a specially powerful detonator. Its gases contain no combustible products. Ammonite is made from ammonium nitrate and dinitronaphthalene. Bellite is a mixture of dinitrobenzine with ammonium nitrate, the latter in excess. Securite consists of the nitrate and dinitrobenzine, but from the proportions used the author supposes that carbon monoxid must be produced. These ammonium nitrate (Sprengel) explosives are deliquescent, and have to be kept in waterproof and airtight canisters and cartridges.

The third group consists of mixtures of the first and second classes, in which a body susceptible to detonation, and generally of an oxidizing character, is exploded, and the products made to act on a combustible. Thus westphalite consists of 95 parts of ammonium nitrate and 5 parts of specially prepared resin. Carbonite, the most important member of the group, is a mixture of about 25 parts nitroglycerine, 30 potassium nitrate, 4 barium nitrate, 40 wood meal, and 1 sodium carbonate. The admixture of so large a proportion of carbonaceous material reduces the temperature of the explosion, and therefore to that extent the liability to ignite firedamp, but on the other hand its products are largely combustible, over 40 per cent. of the gases being carbon monoxid.

The author's conclusions are that the selection of a safety explosive should be based on the following points: (1) The explosion must be due to detonation, and not to simple combustion; (2) if the explosive is a mixture, both the combustible and the oxidizing material must be susceptible of detonation; (3) the products of explosion must be non-inflammable and non-poisonous; (4) the explosive must be safe in handling as well as in action, and compounds of an unstable character which are liable to change should be avoided; (5) the temperature of explosion should be as low as is compatible with rapidity of action. These would seem to be pretty rigid specifications, but, if the author had added to them that for practical purposes a mining explosive should do its work well (that is, according to the resistance of the particular material blasted and the size of the fragments wanted), that it should be convenient to handle, and, above all, that it should be cheap, he would have described an ideal mining explosive,—which, it is needless to say, has not yet been found.

The Manufacture of Scotch Pig Iron.

In the *Engineering and Mining Journal* (June 8) Mr. A. H. Sexton gives the history of the pig iron industry of Scotland, together with an account of the present condition of that trade. He dates the starting-point of the Scotch iron industry in 1801, when the blackband ironstone was discovered, but adds that it was 30 years or more after that before it attained any considerable importance. "Then its growth became very rapid, and for a time Scotland held the place of being the most important iron-producing country in the world. The quantity of iron produced in Scotland is little, if at all, short of what it was in the best days, but the production in other countries has enormously increased, and therefore the relative positions have entirely changed." With the great changes in iron-making all over the world, the industry in Scotland also has advanced, the introduction of the Bessemer and Siemens processes leading to the making of hematite pig, while the basic process has called for a supply of phosphoric pig, so that now the furnaces use considerable Spanish and Mediterranean ores. Two varieties of iron ore are found in the Scottish coal fields, and both are largely used. The favorite is the blackband ironstone, consisting mainly of iron carbonate, with some earthy gangue and usually enough carbonaceous matter for calcining without the addition of other fuel. On calcination the ore loses about 30 per cent. in weight, and then contains about 50 per cent. iron. The other kind is the clayband, an iron carbonate mixed with much clay and other earthy matter. The loss in calcination is less than in the case of blackband, and the roasted ore contains about 40 per cent. of iron. The phosphorus runs high in both sorts, the analysis cited by Mr. Sexton showing 1.20 to 3.05 per cent. phosphoric acid. "Scotch pig" has always been in demand for foundry use, but the term no longer includes all, or indeed the greater portion, of the iron now made in Scotland. Limestone flux occurs in the iron district, and a fossiliferous, phosphatic limestone is used in making basic pig. The fuel is always raw coal, a splint rich in hydrogen and low in fixed carbon, and non-caking, or giving a very soft coke. The modern Scotch furnaces are similar in form to the English. They are cylindrical, cased or bound with iron, and carried on high iron columns. They are usually from 50 to 65 ft. high, with a bosh of 15 to 18 ft., having closed hearths and about eight tuyeres. Larger furnaces have been built, but the tenderness of the coal limits the height, and it has been found expedient to cut down the taller stacks, or run them only partially filled. Mr. Sexton favors a size of about 50 ft. high, with 10 ft. bosh and 8 ft. hearth. Hot blast is employed, regenerative stoves now supplanting the earlier pipe stoves.

Opal in New South Wales.

In an essay by Mr. F. G. de V. Gipps an interesting account is given of the white Cliffs opal field and the geology of the region. The field itself is about 15 miles long, with a width of from ½ mile to nearly 2 miles, and is marked on the surface by boulders of sandstone and quartzite. Fully 95 per cent. of the opal obtained is of no value, some of it being common or semi-opal, and much, although of the noble variety, carrying the color only in minute bars or streaks, or being stained a reddish yellow by iron oxid. An unbroken vein of opal, however small, is never found, it having been broken into larger or smaller fragments, which, however, still retain their position in the vein. The fracturing is due to contraction on hardening from a gelatinous condition, the contraction having produced the internal strains of conchoidal relation to which the coloring of the opal is considered by the author to be most probably due. In addition to veins, the opal is also found in pseudomorphic forms after shells, some of these, when of good color, being very beautiful. There is a wide variety of opal on the field, and the prices paid range from zero to about $125 per ounce, though rarely above $100. In valuing opal many points have to be considered. Color is the first, red fire or red in combination with yellow, blue, and green being the best. Blue by itself is valueless, and green of no great value unless very vivid and the "pattern" good. The color must be "true," not in streaks or patches alternating with colorless stone. Pattern is an important factor, the various kinds being distinguished as "pinfire" when the grain is very small, "harlequin" when the color is in small squares, and "flashfire" when the color shows as a single flash or in very large pattern. The "harlequin" is the most uncommon and the most beautiful. The "ground" or body of the opal should be neither too transparent nor too opaque, a slightly milky, translucent sort being about the best ground. The harder the stone, the better, as, when cut, it is less likely to be injured, and it retains the polish better.

A Ball Mill in West Australia.

Although so many devices have been suggested and experimented with as substitutes for stamps, few are in actual service as compared with the number of stamp batteries, and, of these few, most are of a single type of roller mill, which has been found to do good work on soft ores in the United States. The description, in the *Goldfields Courier*, of a new mill (the Golden Bar) in the Coolgardie gold district, West Australia, is of interest on account of the novelty of the plant, though a record of its working would be of more value. The basis of the system is a Krupp ball mill, nominal capacity of 30 to 35 tons a day, on ordinary quartz, crushed to 30-mesh. The shell is of wrought iron, 7 ft. in diameter by 4 ft. wide. It is lined with chilled steel plates made in sections varying in dimensions, in order that the ultimate loss of steel may be reduced to a minimum. These plates are secured by bolts, and require only a few hours for renewal. In this mill the screening arrangements are of special importance. There are three sets of screens: (1) the mantle plates, perforated by ⅜-in. holes, widening to ¾-in. on the discharge side; (2) screens of strong steel plates with 38 oblong punched holes to the sq. in.; (3) brass wire screens, in this case of 30-mesh (900 per sq. in.), but finer if needed. Each section of screens has a return, so that the ore traversing the section may be discharged as a finished product or returned to the mill for further pulverizing. It is claimed that the wear of steel is only 1½ lbs. per ton crushed to 30-mesh, and that the power required is only 18 h. p., at a speed of 21 revolutions per minute. The balls are from 3 to 5 in. in diameter, when new, and about forty (or 1 ton to 2 cwt.) are used. The amount of ore in the mill is about 15 cwt., and the operation is continuous. The mill crushes dry or wet, and, if dry, is cased in to prevent the escape of dust. It discharges into an elevator hopper.

The remainder of the plant consists of percolating vats for the cyanid process, four, with a capacity of 60 tons each, being used; the other usual adjuncts for the cyanid treatment; a set of 6-ft. Allen amalgamating pans, fitted with copper plates on the sides; a vortex pump for circulation; and an automatic mercury feed, which, by means of slow-motion gear and disc valve, allows one drop of mercury to escape each quarter turn, falling 3 ft. and striking upon a polished steel plate, which sprays it over the charge; elevators, tracks, cars, and pumps for convenient handling of the pulp, etc. The vats are discharged at the bottom; the pans are pumped out.

The World's Iron-Ore Supply.

To the forthcoming volume of "Mineral Resources," for 1894, to be issued by the United States Geological Survey, Mr. John Birkinbine contributes a chapter on the supplies, derivation, and distribution of iron ores, in which he groups the various countries under three heads: (1) Those which mine sufficient iron ore to supply their own demands, but export none, or but small amounts. The United States, Russia, Austria-Hungary, China, Japan, Brazil, and Mexico may be included in the first class. (2) Those which, while consuming domestic iron ores, are obliged to draw largely from other sources in order to obtain sufficient raw material of the required character for the iron manufactured. In this class fall Great Britain, France, and Belgium. (3) Those which, having excellent iron-ore resources, easily exploited, utilize none, or but a small proportion, by making pig or bar iron in domestic blast furnaces or forges, the bulk of the ore being exported to less favored countries. In the third class the principal countries are the German Empire, Spain, Sweden, Algeria, Cuba, Italy, and Greece. Another class might be added, to include the countries known to have iron-ore deposits of which little or no use is made, such as Tunis, Morocco, Persia, Central and Southern Africa, Venezuela, Guatemala Haiti, Servia, etc.

Coal Mining Under the Sea.

Under the caption "Coal Mining Up to Date," an excellent series of papers is being published in the *Iron and Coal Trades Review*, the thirteenth chapter of which appears in the *Review* of May 31. A very large part of the coal area of Durham, Northumberland, and Cumberland, England, is under the sea, and in working the principal seam of this undersea coal in Cumberland, prior to 1886, the bond-and-pillar system was followed and the pillars were left. In that year, according to our authority, the longwall method was introduced to work this seam, and it has been continued to the present time. The crown engineers have fixed the limit of working with bonds only at 21 fathoms of overhead strata from the bed of the sea; with longwall work, 45 fathoms of overlying strata must be maintained ; if less, the working is stopped. In one place, nearly ½ mile beyond the coast line, there is a continuous face of 600 yds., where the thickness of solid strata above is nearly 70 fathoms. The roof is strong sandstone and shale.

The Longwall System.

In the same article of the "Coal Mining Up to Date" series, the author offers some remarks on the longwall system of getting coal, which present the whole question very clearly. It is claimed by some, or perhaps most, authorities that this method possesses several advantages over other systems. Its ruling principle, as defined by our author, is to extract the coal wholly in a continuous long face, whereby the working is greatly facilitated, a larger quantity of round coal is produced, and ventilation is much simplified. "Its greater safety is more apparent when the excavation behind can be completely filled up with *débris*, so that no lodgment of firedamp can take place; the subsidence of overlying strata and injury to coal seams above are reduced to a minimum. This filling up of the waste is obtained from taking down top in the stalls or gangways and the refuse arising from working the coal seam." It is obvious, as pointed out in the article, that thin seams, or seams of moderate thickness, lend themselves most readily to this method, as there will be an abundance of material for packwalls and complete filling. "The preliminary proceeding, in commencing longwall, is to leave large pillars at the bottom of the shaft in each seam [if more than one are to be worked], so that no crush from the subsequent working shall in any way affect the shaft. The main levels for an extensive colliery may be continued from the shaft pillars on each side, either protected by pillars of coal, or by driving out in wide work at once, every road from the shaft being a goaf road. The former method opens out the mine more quickly ; the latter, though tardy, after the strata have been consolidated, generally ensures good permanent roads for haulage and ventilation. Of the main levels the two in the middle should be intakes, one for haulage and the other for traveling, those at the sides being returns from the workings right and left." There are also the systems of longwall retreating, of letting down the coal behind the workings, and various modifications and combinations of longwall with other methods not described.

Treatment of Pyritous Concentrates by Cyanid.

The results of some interesting experiments in treating pyritous concentrates by potassium cyanid are communicated by Mr. A. T. Crosse in a paper read before the Chemical and Metallurgical Society of South Africa. Contrary to a prevalent impression that, if free acid can be neutralized, the chief source of decomposition of cyanid is removed, Mr. Crosse holds that any method leaving ferrous and even ferric hydrate in a freshly precipitated form would not answer, for cyanid takes up these hydrates to form ferro- or ferric-potassic cyanid. Working on the principle that heat dehydrates the oxids, Mr. Crosse has found what he proposes as the best method,—namely, heating the concentrates on iron plates, or by some other suitable arrangement, to a temperature just below dull red heat. After cooling, they are put in the vat and thoroughly washed with water until no iron is found by testing the wash water with potassic-ferric cyanid. Then they are washed with lime water, and leached with cyanid in the usual way, though it is recommended to let the solution percolate during the whole time of treatment.

Manganese in Georgia.

According to a writer in the Chattanooga *Tradesman* (June 15), Georgia in the past, between 1880 and 1888, ranked second in the United States as a producer of manganese ore, Virginia holding the first place. The Cartersville district, in Bartow county, was the main producer in the State until 1891, when the Cave Spring district, in Floyd county, became a rival. Since then, shipments from both districts have been greatly reduced, owing to high freight rates to Pittsburg, the principal market. At present, and during 1894, a revival in manganese mining has occurred. Several mines are now being worked in the Cartersville district on leased ground, at a royalty of $1 per ton.

The writer quotes, from Dr. J. W. Spencer's report as State geologist, descriptions of the geological features of the manganese districts of Georgia, adding the results of his own observations. Cartersville is now shipping from 3 to 4 tons of washed ore daily ; the Cave Spring district, which shipped 3000 tons in 1890–91, is now almost idle. Other manganese localities are reported.

Manganese ore is used mainly for manufacture of spiegeleisen and ferromanganese, which are alloys of iron and manganese, employed in steel-making; for the manufacture of bronzes, and of chlorine for bleaching purposes; in decolorizing glass, and in coloring glass, pottery, and brick ; and for making various chemical products.

Mining Subsidences in the Black Country.

TROUBLES similar to those met in the coal-mining regions of Pennsylvania and elsewhere in the United States, caused by the sinking of surface land undermined by colliery excavations, are not infrequent in Europe, the areas built over being, however, mainly occupied by miners' dwellings and villages of small importance as a rule. The question of liability for damages to property or loss of life and injury to persons is brought up anew by an account given in the Birmingham (England) *Post* and republished in the *Architect and Contract Reporter* (May 31) of recent happenings in the "black country," especially in the neighborhood of Quarry Bank, Stone Hill, Netherton, and other places, where a serious state of things has been brought about by mining operations. In some of these towns and villages dwellings intact are almost a novelty, except where residences have had to be rebuilt, or in the very rare cases where the mines have been purchased by the owners of surface property. Laws enacted in the time of George III, when most of the coal lands now more or less densely populated lay waste, gave to the "lord of the manor" power not only to do anything he liked with the coal within certain specified inclosed areas, but also to "soil" underneath the "common water, land, and other things," without being liable for compensation ; but, as a kind of set-off to these almost unlimited privileges, there is a clause stating that he must "do as little damage as may be." This very indefinite restriction has been made the basis of suits in equity, but litigation for damages has made no practical progress. "Apart from the overwhelming legal difficulties surrounding the matter," says the *Post*, "the whole question of compensation is beset with great and conflicting interests. On the one hand are the interests of the miners, the ironworkers, and of all who desire that the collieries should be worked thoroughly, and on the other hand the interests of the owners of houses." In other parts of the district outside the "inclosed areas" of the acts and where the "lord of the manor" is subject to common law, the custom is for him to erect a new house for every one destroyed. As to the "inclosed areas," the *Post* suggests a compromise arrangement, by which the owners of collieries should contribute a portion of the cost of repairs and renewals.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy.

*32408. The Magnetic Separation of Iron Ores.—Scientifically and Commercially Considered. Clinton M. Ball (Eng Mag–Aug.) 3500 w.

*32422. The Sheffield Steel Industry. R. A. Hadfield (*Ir & Coal Tr Rev*–May 31.) 2400 w.

32432. The Manufacture of Scotch Pig. A. H. Sexton (Eng & Min Jour–June 8.) 1300 w.

32433. The Chemist and the Blast Furnace. William B. Phillips (Eng & Min Jour–June 8.) 800 w.

32441. Manufacture of Steel Projectiles in Russia. Sergius Kern (Am Mfr & Ir Wld–June 7.) 500 w.

32460.—$1.50. Specifications for Structural Steel. H. H. Campbell, with Discussion and

Correspondence (Am Soc Civ Eng–April.) 37000 w.

32505. The Chemistry of Pig Iron and Its Application to Casting for Electrical Purposes. B. S. Summers (Elec Engng–June.) 2400 w.

32507. Extraction of Gold by Electrolysis. A. J. Rogers (Elec Engng–June.) 1500 w.

32542. Natural or Suction Draft Cupolas. Ill. Thomas D. West (Ir Tr Rev–June 13.) 4200 w.

32556. Early Iron Making in North Carolina. Ill. J. D. Kase (Eng & Min Jour–June 15.) 400 w.

32557. Treatment of Pyritous Concentrates by Cyanide. A. T. Crosse (Eng & Min Jour–June 15.) 900 w.

32604. Blast Furnace Construction and Working in Upper Silesia. A. Gouvy (Am Mfr & Ir Wld–June 14.) 1100 w.

32605. Compressed Air: Its Utility and Advantages as Applied to Foundry Purposes. Howard A. Pedrick (Am Gas Lgt Jour–June 17.) 3000 w.

†32619. The Strength of Iron as Affected by Tensile Stress While Hot. De Volson Wood (Am Soc Mech Eng–June.) 250 w.

†32639. The Lixiviation of Silver-Ores by the Russell Process at Aspen, Colorado. Willard S. Morse (Tr Am Inst Min Eng–June.) 3600 w.

†32641. The Assay of Silver Sulphides. H. Van F. Furman (Tr Am Inst Min Eng–June.) 1400 w.

†32644. Milling Arizona Gold-Ores with a "Colorado" Stamp-Mill. Ill. Willard S. Morse (Tr Am Inst Min Eng–June.) 1200 w.

†32645. Treatment of Roasted Gold-Ores by Means of Bromide. Richard W. Lodge (Tr Am Inst Min Eng–June.) 700 w.

†32646. Nickel and Nickel Steel. Remarks in discussion of Paper of F. L. Sperry by John Birkinbine (Tr Am Inst Min Eng–June.) 1000 w.

†32647. The Present Limitations of the Cyanide Process. C. W. Merrill (Tr Am Inst Min Eng–June.) 1400 w.

†32649. A New Slag-Car for Lead and Copper Blast-Furnaces. Carl Henrich (Tr Am Inst Min Eng–June.) 2200 w.

†32651. The Cyanide Process as Applied to the Concentrates from a Nova Scotia Gold-Ore. Richard W. Lodge (Tr Am Inst Min Eng–June.) 800 w.

†32653. Assays of Copper and Copper Matte. Discussion (Tr Am Inst Min Eng–June.) 12000 w.

32670. The Place of Iron in Nature. John T. Kemp, in Knowledge (Sci Am Sup–June 22.) 1400 w.

*32717. Recent Progress in Siemens–Martin Furnace Construction. Ch. Walrond (*Col Guard*–June 14.) 2000 w.

32742. The Proposed Iron and Steel Scale (Ir Tr Rev–June 20.) 900 w.

32771. On Scheibler's Modification of the Basic Bessemer Process. E. Schrodter (Am Mfr & Ir Wld–June 21.) 700 w.

32774. Joseph Hall's Process for the Manufacture of Aluminum. Ill. (Eng & Min Jour–June 22.) 1100 w.

32790. Keep's Cooling Curves.—A Study of Molecular Changes in Metals Due to Varying Temperatures. W. J. Keep (Ir Age–June 27.) 2400 w.

32857. The Rate of Solution of Gold in Cyanide Solutions. A. W. Warwick (Eng & Min Jour–June 29.) 1400 w.

*32863. The Manufacture of Tin-Plate in Austria (*Bd of Tr Jour*–June.) 2200 w.

*32889. Cleaning and Concentrating Outcrop Iron Ores. Walter J. May (*Col Guard*–June 21.) 2200 w.

*32890. Technical Progress Realized in the Production of Pig Iron in Germany and Luxemburg Since 1882. M. Van Vloten (*Col Guard*–June 21.) 4000 w.

*32891. A Competitive Trial of Flue-Heated Coke Ovens. A. Hüessner (*Col Guard*–June 21.) 500 w.

32950. Some Notes on the History of Electro-Smelting. Ill. Alfred H. Cowles (Pro Age –July 1.) 3400 w.

32973. The Ohio Steel Company's Plant at Youngstown, Ohio. Ill. (Sci Am Sup–July 6.) 1300 w.

*33049. The Slavianoff Electric Metal-Casting System. Ill. (Abstract.) A. Lohmann (*Col Guard*–June 28.) 1500 w.

*33051. The Great Western Railway Works, Swindon. Ill. (*Eng*–June 28.) 3200 w.

*33074. The Iron Industry of New South Wales. Editorial (*Ir & Coal Tr Rev*–June 28.) 1800 w.

Mining.

*32412. Mining Subsidences in the Black Country. From the Birmingham Post (*Arch*–May 31.) 2000 w.

32430. The Gold Belts of Nevada. Dan De Quille (Eng & Min Jour–June 8.) 1800 w.

32450. The Ward District.—Boulder Co., Col. Ill. Howard R. Burk (Min Rev–June 7.) 2500 w.

*32568. Mining Explosives. Vivian B. Lewes, with Discussion (*Col Guard*–June 7.) 4800 w.

*32569. Electric Coal-Cutting at Glenclelland Colliery. Ill. George A. Mitchell (*Col Guard*–June 7.) 3500 w.

*32570. Causes of Explosion in Lignite Briquette Factories. Rudolf Holtzwart and Ernst von Meyer (*Col Guard*–June 7.) 1500 w.

*32580. Mine Sampling. Editorial (*Min Jour*–June 8.) 1500 w.

*32586. Gold in Scotland (*Fairplay*–June 7.) 1700 w.

32597. Manganese in Georgia. Anon. (Tradesman–June 15.) 2200 w.

†32637. The Ducktown Ore-Deposits and the Treatment of the Ducktown Copper Ores. Ill. (Tr Am Inst Min Eng–June.) 22500 w.

†32638. Notes on a Southern Coal-Washing Plant. Ill. J. J. Ormsbee (Tr Am Inst Min Eng-June.) 3500 w.

†32640. Hysteromorphous Auriferous Deposits of the Tertiary and Cretaceous Periods in New Zealand. Henry A. Gordon (Tr Am Inst Min Eng-June.) 3800 w.

†32642. The Albion Phosphate District. E. T. Cox (Tr Am Inst Min Eng-June.) 1500 w.

†32643. Mining Leases. Francis I. Freeland (Tr Am Inst Min Eng-June.) 2200 w.

†32650. The Northeastern Bituminous Coal-Measures of the Appalachian System. George S. Ramsay (Tr Am Inst Min Eng-June.) 3000 w.

†32652. The Florida Rock-Phosphate Deposits. G. M. Wells (Tr Am Inst Min Eng-June.) 2800 w.

32664. The Canadian Nickel Mines. (Ir Age-June 20.) 1700 w.

*32714. Experiments with Explosives. Be gassessor Winkhaus (*Col Guard* - June 14.) 4800 w.

*32715. The Leinster Coal-field. R. Sutcliffe (*Col Guard*-June 14.) 2200 w.

*32716. The Aniche Collieries, Nord, France. (*Col Guard*-June 14.) 1600 w.

*32718. Experiments in Mine Ventilation. R. Hausse (*Col Guard*-June 14.) 700 w.

*32760. The Necessity for Competent Geological Surveys of Gold Mines. Nicol Brown (*Min Jour*-June 15.) 2000 w.

32772. Cost of Electric Coal Cutting in Scotland. Statements of George A. Mitchell (Am Mfr & Ir Wld-June 21.) 1700 w.

32773. Porphyry. T. A. Rickard (Eng & Min Jour-June 22.) 1100 w.

32811. Timbering in the Isabella Incline. Francis T. Freeland (Min & Sci Pr-June 22.) 800 w.

32858. Mining and Treatment of Quicksilver Ores at Guadalcazar, Mexico. Ill. W. H. Rundall (Eng & Min Jour-June 29.) 1800 w.

32859. The Mineral Fuels of Chile. (Eng & Min Jour-June 29.) 1600 w.

*32887. The Remuneration of Mine Surveyors in Germany. (*Col Guard*-June 21.) 800 w.

*32888. The Ressaix, Leval, Paronnes and Sainte-Aldegonde Collieries, Belgium. J. W. P. (*Col Guard*-June 21.) 1500 w.

*32896. Petroleum and Asphalt in Eastern Europe and Asia. (*Chem Tr Jour*-June 22.) 1300 w.

*32899. Remarks on the Banket Formation at Johannesburg. A. R. Sawyer (*Min Jour*-June 22.) 2700 w.

*32900. The Murchison District, W. A. Brenton Symons (*Min Jour*-June 22.) 4500 w.

*32902. Chrome Iron Ore Mining in Asia Minor. W. F. Wilkinson (*Min Jour*-June 22.) 1800 w.

†32987. Coal Mining in Australia. D. (*Ind Engng*-June 1.) 900 w.

32988. Estimating Mine Values. Editoria (Min Ind & Tr-June 27.) 1200 w.

33010. Gold Mining in Southern States—Present Conditions and Future Prospects. W. M. Brewer (Tradesman-July 1.) 1500 w.

*33047. Methods of Dealing with Coal Dust. Anon. (*Col Guard*-June 28.) 3500 w.

*33048 Mine Regulations in the Bonn Inspection District, with the 1895 Modifications and Additions. (*Col Guard*-June 28.) 6300 w.

Miscellany.

32429. Remarks on the Recent English Decision in the Cyanide Case. C. W. Merrill (Eng & Min Jour-June 8.) 1500 w.

Serials

22586. The Mineral Hydro-carbons. Henry G. Hanks (Min & Sci Pr-Began June 2, 1894—29 parts to date—15 cts. each).

27329. Coal Mining Economy Up to Date. Anon. (*Ir & Coal Tr Rev*-Began Nov. 23, 1894—17 parts to date—30 cts. each).

28932. Cripple Creek Phonolite Dikes, Raven Hill. Edward Skewes (Eng & Min Jour-Began Feb. 2—3 parts to date—15 cts. each).

29599. Mining in Spain (Asturias) (*Min Jour*—Began Feb. 16—4 parts to date—30 cts. each).

30461. The History of Iron. Notes from Dr. Ludwig Beck (Ir Age—Began March 28—7 parts to date—15 cts. each).

30912. The Glasgow Iron and Steel Company's Works, Wishaw. Ill. (*Engng*-Began April 15—Ended June 28—5 parts—30 cts. each).

31793. The Commercial Use of Minerals. Norman Danvers Power (*Aust Min Stand*-Began April 13—Ended May 4—4 parts—30 cts. each).

31908. Victorian Gold Mining. Thomas Cornish (*Min Jour*-Began May 11—6 parts to date—30 cts. each).

32574. Recent Improvements in Galvanizing. Ill. (*Eng*-Began June 7—1 part to date—30 cts).

32579. Coolgardie. Brenton Symons (*Min Jour*-Began June 8—2 parts to date—30 cts. each).

32770. Swedish Iron Ores. From Report of John Birkinbine (Am Mfr & Ir Wld-Began June 21—2 parts to date—15 cts. each).

32901. The Rand Conglomerate. M. Draper (*Min Jour*-Began June 22—Ended June 29—2 parts—30 cts. each).

32979. Silver Mining and Smelting in China (*Ind & East Eng*-Began June 1—1 part to date—45 cts).

33071. On Deep Mining in Mexico. Edward Halse (*Min Jour*-Began June 29—1 part to date—30 cts).

33072. The Copper and Tin Deposits of Chotanagpore, Bengal, India. Robert Oates (*Min Jour*-Began June 29—1 part to date—30 cts).

MUNICIPAL ENGINEERING

Bacteria and Other Organisms in Water.

An exceedingly interesting and instructive paper on this subject, read April 17 before the American Society of Civil Engineers, by John W. Hill, and printed in the May number of the *Transactions*, elicited a discussion scarcely less instructive than the paper itself, in which debate some of the most prominent engineers in the country joined. An attempt to give here anything more than an outline of this paper and the remarks made upon it would fail. The paper itself comprises a large amount of tabulated information, and is illustrated with plates delineating a considerable variety of living and dead floating impurities found in water, including algæ, diatoms, desmids, rhizopods, infusoria, etc., with other miscellaneous solid impurities. Accounts of examinations of water, filtered and unfiltered, supplied to cities for potable and domestic use occupy considerable space.

"In making tests for the bacteria in water, the method pursued by the author has been to collect the water in carefully-sterilized 2 oz. glass-stoppered bottles, enclosed in small sterilized tin canisters, and to inoculate the gelatine or agar plates with one or more drops of the water under examination, and then, after mixing the water and melted media, heating the mouth of the tube, and singing the cotton plug to destroy any chance organisms, to pour the solution of nutrient media and water into a sterilized Petri dish. Usually from 6 to 10 cu. cm. of gelatine or agar is used, and the number of drops of water from a sterilized pipette depends upon the extent of pollution, or, rather, the number of bacteria suspected in the water. From a very polluted water one drop, or $\frac{1}{18}$ cu. cm., is too much, the number of bacteria present being so great as to be innumerable by the Wolffhugel method, and absorbing the nutrient media so completely as to prevent the growth of some varieties. In such cases, after shaking the bottle containing the sample of water under investigation, it is customary to dilute this several times with sterilized water and multiply the actual count of bacteria accordingly. With comparatively pure natural waters (which are, unfortunately, rarely found) ¼, ½, or 1 cu. cm. is used for inoculation purposes; a single drop from one of the ordinary dropping-tubes, or pipettes with rubber tops, may contain from $\frac{1}{12}$ to $\frac{1}{24}$ cu. cm., and, after the use of one of these, it must be measured to determine the proportion of a cubic centimeter used in the inoculation. The period of incubation which has been allowed is 5 days at room temperature, except with filtered waters, when the time has been extended from 10 days to 2 weeks or more. The growth of bacteria is rapid in polluted water, and, if liquefying organisms are present, as they generally have been in the waters experimented with, the count must not be delayed beyond 4 or 5 days, or the liquefiers will spread over the plate and obscure some of the non-liquefying colonies. It is a noticeable fact in the author's experience that plates inoculated with water from the best type of filters require more time for the incubation of the colonies of bacteria than those with unfiltered water. Thus the germs left in the water after filtration grow at a slower rate than many that are in the water before filtration. From which it would follow that in counts of plates of unfiltered water at the end of a few days some bacteria are very liable to be overlooked because they have not grown. This may have no significance, but it is well known that the typhoid bacillus is comparatively a slow-growing germ, and might be obscured on an ordinary growing plate. While the growth of many of the bacteria is much slower at room temperature subject to variations than in the incubator, where the temperature is maintained quite constant, still the rapid-growing liquefying germs in the incubator are frequently seen to spread and obliterate the non-liquefiers, and destroy the germs of slow growth altogether."

Among the waters thus examined were samples from the public mains of Cincinnati and Jersey City. Quotations from reports of examinations of water taken from European water supplies, as made by eminent scientists, were liberally made. One of the most interesting parts of the paper to the popular reader is a report of an examination of Apollinaris water.

"Apollinaris water is regarded everywhere as the 'queen of table waters,' and is in such demand for drinking purposes that in our country it commands a price of from 75 cents to $1 per gallon,—a very high price indeed for even an absolutely pure drinking water. Recognizing the extent to which this water is used for drinking purposes, and having a curiosity to know more about it, the author recently made three plate cultivations on gelatine from a fresh unopened bottle of Apollinaris water with the following results:

"Plate I, 1984, plate II, 1728, plate III, 2112 bacteria per cubic centimeter. The standard for the filtered water from the London water works has been stated as 100 bacteria per cubic centimeter, and the number has been so low as 18–20 per cubic centimeter, and upon one occasion absolutely sterile water was reported. Before inoculating the gelatine with the Apollinaris water, great care was taken to heat the neck of the bottle and scorch the cork before the wires holding it in the bottle were cut; and, everything being in readiness, the inoculations were quickly made.

"While the number of germs in the Apollinaris may be more or less (probably less by the inhibiting action on the growth of bacteria of the 'carbonic acid gas' in the water) than when originally bottled, still this is the condition in which we drink it when taken from freshly-opened bottles. Among the organisms found on the gelatin plates was Cladothrix dichotoma, which is usually held to indicate the presence of considerable organic matter in water. The water reacted quite alkaline, and it would therefore be good breeding material for most water bacteria, especially the cholera bacillus.

"The spring from which this well-known water is obtained is located in the valley of the Ahr, in Rhenish Prussia, and is said to have a capacity of 27,400 United States gallons per day, while the present output of bottled water amounts to 12,330 gallons per day. A number of chemical tests have been made of Apollinaris water, but from the information available it seems not to have been tested for bacterial life before."

A statement made by Mr. Hill that typhoid can be propagated only through drinking water was challenged, in the discussion following the reading, by Mr. Rudolph Hering, who stated that this view is opposed by numerous high authorities. He stated the two prevailing theories, "the drinking water theory" and "the ground water theory," each of which has numerous supporters; and, while admitting that most cases of typhoid are propagated by drinking water, he asserted positively that "there are other means of disseminating this disease."

Natural Gas a Pioneer for Artificial Fuel Gas.

NATURAL gas is treated from the standpoint of the above title by Mr. Donald McDonald in a paper read at the eighteenth annual meeting of the Western Gas Association, Pittsburg, May 16, and printed in *American Manufacturer* (May 24). After having been taught the advantages of gaseous fuel, the author regards it as certain that its users will never return to coal, and, natural supplies failing, they will resort to artificial fuel gas. He, moreover, regards it as certain that the future demand for gas as fuel will be tenfold that of gas for illumination. Natural gas has taught thousands of people the inestimable advantages of gaseous fuel, and it is safe to say that, having once learned this lesson, they will never willingly return to the use of coal. It has also demonstrated the fact that the demand for gas for fuel will be at least ten times that of gas for light. It has also supplied the means for many thousands of very cheap experiments on gas-appliances. The net result of this is that these appliances have been improved to such an extent that people can now afford to pay 40 cents a thousand for gas, where formerly they found it too expensive at ten cents a thousand. Of course, if artificial gas had attempted to enter the field of domestic heating during the early period of these experiments, it would have been impossible to furnish either satisfaction to the consumer or profit to the company. Now, however, the case is far different. The experiments have been tried, the houses are piped, the connections made, the meters set, and, more than this, the prejudices of consumers have been overcome, and housewives have learned that a gas fire is less dangerous than a coal fire, and that it means the difference between comfort and drudgery. Any artificial gas company which had attempted to perform this pioneer work in a city as large as Pittsburg would have lost hundreds of thousands of dollars before it had brought the matter to the favorable condition in which it now is.

"It is safe to say that, if natural gas were to fail to-morrow in any city where artificial gas could be had as cheap as 80 cents a thousand, the demand on the artificial gas would immediately show a marked increase. The kitchens, the bath-rooms, and, in many cases, the parlors would continue to use the gas-stoves which they have already set. If artificial gas could be had as low as 50 cents, we would find added to this list many of the dining-rooms, and many best rooms, which are not used as sitting-rooms."

There still remains something to be done by the companies who would create and increase a demand for fuel gas. They must "prepare for fuel at as low a figure as is consistent with a fair profit on their investments, and, in arriving at this figure, they must leave out of the fund on which interest is to be paid all reference to the fact that iron pipe once cost $100 a ton, that much of it that was laid proved to be useless and had to be replaced, or that opposition companies have been bought out at large cost, and their works allowed to lie idle."

These things may be burdens on the old line companies, but they will not be burdens "on companies that may be organized"; and, if a general demand for fuel gas at the price named is created, that demand will be met by new companies, if the older companies do not supply it.

"In figuring on the possibilities of cheap gas in this connection, it must be remembered that all of the items usually included under the head of cost of gas per thousand in the holder would be considerably reduced if the output of the gas were increased tenfold." While these items, included under the head of distribution, general expense, depreciation, and management, will be increased very little for the same number of consumers over what they are now, the cost per thousand will be very greatly cut down.

"I will not say in this paper how I believe it possible for a large volume of gas for fuel and light to be sold. It is a figure which will vary greatly in each locality, but I do believe that it is possible to bring the figure down so low that the wealthier class of people can afford to use gas to the entire exclusion of coal, while those not so fortunate will find a large use for it in their less constant fires"

But not only must the fuel be cheapened; cheaper and better fixtures must be supplied for burning it. The products of combustion must not be allowed to escape into rooms in which gas-stoves are used for warming, except for short periods. Continuous escape of such products becomes a nuisance after a short time. The water vapor condenses on walls and windows, and on cold furniture, to everybody's discomfort, and there is also a danger that the carbonic acid gas may sometimes travel along with others more injurious. Means must therefore be provided for conveying these products into the outside air, after extracting nearly or quite all their heat from them.

Disposal of City Waste.

A PAPER by Col. George E. Waring, Jr., commissioner of street cleaning of the city of New York, in *The North American Review* for July, deals with this important subject. At the outset it is stated that, "while the theoretical value of discarded matters is recognized, the cost of recovery is still an obstacle to its profitable development." Separation of the manure from the very large amount of water contained in sewage cannot by means now known be effected profitably. This seems to be a sweeping statement as against current schemes for the disposal of sewage considered as a commercial business. However, there are other wastes in cities, the utilization of which is not embarrassed with the presence of great bodies of water, and which admittedly promise profit sufficient "to make it worth while to consider them and their possible value with a good deal of care and to make them the subject of conclusive experiment." These wastes are found in the general mass usually classed as garbage, ashes, and street-sweepings. From these "Italian workmen fish out such as they can of the rags, bones, bottles, and other things of value that the material may contain. Each of the fifteen dumps [in New York] is worked by its own gang for its own padrone, and these pay to the general contractor enough more than he has to pay to the city to leave him a satisfactory profit. These scow-trimmers were paid $10.50 per week each until 1878, since which date no charge has been made for labor, the recovered matter being accepted as payment. Beginning with 1882, the privilege of scow-trimming brought to the city a money compensation of from $75 to $90 per week. The payment increased gradually, until in 1887 it reached $320 per week; in 1888, $685; in 1889, $1000; in 1890, $1068; in 1891, $1770; in 1892-93, 1795. At the end of 1894 it had fallen to 1675. There were occasional deductions on account of the temporary closing of the dumps, but for some years the city has received annually over $50,000 worth of labor and about $90,000 in cash as the value of the privilege of gleaning its dust chutes." The articles obtained are rags of various qualities; soft wools; rubber; soda-water bottles; lager-beer bottles; seltzer-water bottles and bottles of other sorts; iron; zinc; copper; brass; pewter; paper; tomato cans (for the solder); old shoes; hats; broken glass; carpets; rope; brushes; fat; hemp twine; and cloth. The prices obtained by the gleaners for these articles are named. The system of collecting, must, from necessity, be very imperfect, and Col. Waring thinks that the "public authorities might with advantage take control of the whole business."

"Such control would involve the suppression, or the public employment, of the push-cart man, who jingles his string of bells through the streets and carries on a more or less illicit traffic with domestic servants. These peddler-buyers are no more tolerable than were the long-ago discarded rag-pickers. Those who have cast-off things to sell should be made to take them to licensed located dealers, whose transactions can be held under proper supervision. The municipality should—in the interest of the public safety, as well as of the public finances—take up and carry on for itself, or through contractors whom it could control completely, the whole business of removing from houses whatever householders may wish to get rid of and will not take the trouble to carry for sale to a dealer."

Without making any precise calculation (which would be manifestly impracticable) Col. Waring estimates that the amount so collected would reach a value per year of something over $7,000,000, "enough to pay all the cost of street cleaning and street sprinkling, and, in addition thereto, to repave the whole city within a very few years, so far as this is needed, and to keep the pavement in repair perpetually. And he thinks "that in due time it would pay for a complete supply of public urinals, latrines, and other items of municipal housekeeping." This estimate is based upon the supposition that wastes of the kind considered will amount to 1 cent per day per person on the average.

The paper further deals with methods of collection and treatment of rubbish and garbage in general, and advocates the separation, and separate collection, of paper and other like rubbish, street-sweepings, garbage, and ashes; and maintains that it is only because "each one of these classes bedevils all the others that final disposal is such a serious problem.

"Paper, rags, and rubbish of every kind should be collected only by the city's own carts, or the city's own contractors. . . . . Paper and all manner of dry rubbish being rigidly kept in-doors until taken by the collector, the sweepings of the streets—especially after the improved repaving—will consist of little else than horse-droppings; and, while these have not much commercial value in New York, they can at least be got rid of inoffensively and without much cost. . . . As soon as the separation is fairly accomplished, contracts will be made for the reduction, utilization, or cremation of the garbage. . . . As to the disposal of ashes, this separation will render them such a good material for filling of lands under water that there will no longer be any necessity for carrying them out to sea." In conclusion, Col. Waring expresses the view "that, while the question of the disposal of a city's wastes is full of difficulty, it is also full of promise."

THE danger of relaxing restrictions established for the purpose of preserving the beauty of public pleasure-grounds has been recently exemplified in Central Park, New York. This episode is briefly narrated and editorially commented upon in *Garden and Forest* (June 12). A larger liberty of access to the areas was allowed, and the familiar signs, "Keep off the Grass," were removed in some places. It is asserted that the park has suffered serious defacement since the relaxation of a time-honored restriction. The "shrubs and herbaceous plants in bloom were broken and carried away by the armful, in spite of the police."

"A significant fact was stated by a park policeman, who said that for the first few days after the lawns were thrown open people could hardly be persuaded to walk on them. Those who frequented these portions of the park had become so accustomed to walking on the paths and sitting on the benches that they had to be invited to walk in and sit down on the grass before they would accept what was considered such a favor. Of course it did not take long to educate people up to their new privileges; but the fact that they had already been educated to keep off the grass is certainly worth considering."

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Gas Supply.

32439. The Storage and Handling of Oils in a Gas Works. D. J. Collins, with Discussion (Am Gas Lght Jour–June 10.) 7600 w.

*32489. "Slopers" at Brentford (*Jour Gas Lgt*–June 4.) 1900 w.

*32552. Test of the Welsbach Incandescent Gas Burner. E. V. Stebbins (Sib Jour Eng–June.) 1500 w.

*32727. The Monier System of Cement Construction as Applied to Gas-Works. Ill. F. D. Marshall, with Editorial and Discussion (*Jour Gas Lgt*–June 11.) 9000 w.

32768. Gaseous Fuel in the Retort House. Ill. T. S. Cleminshaw, in the London Journal (Am Gas Lght Jour–June 24.) 2200 w.

32780. Making Working Diagrams for Gas-Pipe. Ill. W. B. Gray (San Plumb–June 15.) 5700 w.

*32791. Some Improvements in the Methods of Manufacturing Sulphate of Ammonia. C. Stafford Ellery, with Discussion (*Gas Wld*–June 15.) 3800 w.

*32792. Illumination. W. Ivison Macadam, with Discussion (*Gas Wld*–June 15.) 4500 w.

*32793. Photometry as Applied to the Verification of the Illuminating Power of Gas Supplied to Towns. Ill. William Sugg (*Gas Wld*–June 15.) 5000 w.

*32794. Unaccounted for Gas. D. Irving, with Discussion (*Gas Wld*–June 15.) 7000 w.

*32795. The Practice of Districting with a View to the Equalization of Pressure. F. W. Cross (*Gas Wld*–June 15.) 4200 w.

*32796. Acetylene and the Part it Plays in the Luminosity of Flame. Vivian B. Lewes (*Gas Wld*–June 15.) 6000 w.

*32797. The Combustion of Coal Gas for Fuel Purposes. Vivian B. Lewes, with Discussion (*Gas Wld*–June 15.) 6000 w.

*32799. The Management of, and Remuneration to, Gas Workers. John M'Crae, with Discussion (*Gas Wld*–June 15.) 5000 w.

*32800. On Some Matters of Interest in Connection with the Washing of Crude Coal Gas. Lewis T. Wright, with Discussion (*Gas Wld*–June 15.) 5300 w.

*32801. Electricity Supply from Town Gas. F. H. Medhurst, with Discussion (*Gas Wld*–June 15.) 5000 w.

*32802. Notes on Luminous and Non-Luminous Combustion. B. H. Thwaite (*Jour Gas Lgt*-June 18.) 3000 w.

*32915. Notes on Experiments with Liquid Gas Enrichers. T. Stenhouse (*Gas Wld*-June 22.) 1400 w.

*32916. Manufacture of Cyanides. From Mr. Heller's Report on the Chicago Exposition (*Gas Wld*-June 22.) 1100 w.

32941. Cumulative Generators in Soft Coal Gas Making. Ill. James L. Hastings (Am Mfr & Ir Wld-June 28.) 3000 w.

32942. Testing Prepared Tar. C. Lunge (Am Mfr & Ir Wld-June 28.) 1400 w.

32944. Inaugural Address of President Robert Mitchell before the Thirty-second Annual Meeting of the Incorporated Gas Institute (Am Gas Lgt Jour-July.) 5000 w.

Sewerage.

*32895. Sewage Purification. Ill. Charles H. Beloe (*Ind & Ir*-June 21.) 2000 w.

Streets and Pavements.

32503. How to Make a Good Paving Brick. Prize Essay by George W. Kummer (Brick-June.) 2800 w.

32856. Street Work, Boston, 1894 (Eng Rec-June 29.) 2400 w.

*32961. Asphalt Pavements in New York (Paving-July.) 1200 w.

*32962. California Asphaltum and Bituminous Rock. Clifford Richardson (Paving-July.) 3200 w.

33025. How to Make a Good Paving Brick. T. Townsley (Brick-July.) 2200 w.

Water Supply.

32442. Water Works and Their Management. L. M. Case, with Discussion (Fire & Water-June 8.) 6800 w.

32459.—$1.50. A Line of 28-in. Cast-Iron Submerged Pipes Across the Willamette River, at Portland, Ore. Ill. Franklin Riffle and Albert S. Riffle, with Discussion (Am Soc Civ Eng-April.) 15500 w.

32553. Some Practical Experience with a Meter System. J. B. Newhall (Fire & Water-June 15.) 1600 w.

32737. The Ipswich, Mass., Water-Works (Eng Rec-June 22.) 900 w.

32786.—$1.50. Bacteria and Other Organisms in Water. Ill. John W. Hill, with Discussion and Correspondence (Am Soc Civ Eng-May.) 14000 w.

*32803. Hydraulic Lifts on the Water Supply System of Cologne. (Abstract.) Herr Froitzheim (*Jour Gas Lgt*-June 18.) 1500 w.

32873.—75 cts. Some Observations on the Temperature of Surface Waters; and the Effect of Temperature on the Growth of Micro-Organisms. George C. Whipple, with Discussion (Jour of New Eng Water Works-June.) 8000 w.

32874.—75 cts. An Experience with Anchor Ice and a Recording Pressure Gage. Charles W. S. Seymour (Jour of New Eng Water Works-June.) 1400 w.

32875.—75 cts. How to Reduce the Excessive Consumption of Water. J. C. Haskell-with Discussion (Jour of New Eng Water Works-June.) 4800 w.

32876.—75 cts. A Description of the Water Works at Webster, Mass. Frank L. Fuller (Jour of New Eng Water Works-June.) 2500 w.

32933. Our Experience with Water Meters. John B. Heim (Fire & Water-June 29.) 1800 w.

*32960. Pure Drinking Water for Cities. Frederick A. Kummer (Paving-July.) 1500 w.

†32978. The Rajkat Water Works, Bombay. Robert Bell Booth (*Ind & East Eng*-June 1.) 1900 w.

Miscellany.

32521. The Defacement of City Parks. Editorial (Gar & For-June 12.) 1600 w.

*32606. Dwellings of the Poor. Alderman Cortis (*San Rec*-June 7.) 3800 w.

†32618. A Portable Disinfecting Plant. Ill. W. H. Francis (Am Soc Mech Eng-June.) 700 w.

32695. The Carson-Trainor Trench Machine. Ill. (Eng News-June 20.) 1500 w.

32782. The Municipal Water Works and Electric Light Plant of North Attleboro, Mass. Ill. (Elec Eng-June 26.) 700 w.

*32798. The Transfer of Gas and Water Undertakings to Public Authorities. William Newbigging, with Discussion (*Gas Wld*-June 15.) 3500 w.

†32822. The Disposal of a City's Waste. George E. Waring, Jr. (N Amer Rev-July.) 3000 w.

*32963. Progressive Municipal Work in Philadelphia. Ill. Anon. (Paving-July.) 1100 w.

*33017. The Progress of Municipal Reform, 1894-5. Clinton Rogers Woodruff (Am Mag of Civ-July.) 3200 w.

33026. The New York Botanical Garden. Editorial (Gar & For-July 3.) 1200 w.

Serials.

5358. Sewage Purification in America. Ill. (Eng News-Began July 14, 1892—48 parts to date—15 cts. each).

30971. Gas Power in the American Market. Ill. (Pro Age-Began April 15—6 parts to date—15 cts. each)

31082. Water Supply and Pipe Distribution. F. C. Moore (Fire & Water-Began April 20—8 parts to date—15 cts. each).

31701. Fires and Fire Engines in the Olden Times. William Perry (Can Eng-Began May—2 parts to date—15 cts. each).

32538. Simple Methods for Solving Problems Relating to the Flow of Gas in Pipes. William Cox (Pro Age-Began June 15—Ended July 1—2 parts—15 cts. each).

32575. Some Figures Relative to the Cost of Producer Gas. W. H. Booth (*Elec Rev*-Began June 7—Ended June 14—2 parts—30 cts. each).

RAILROADING

Counter-Balancing Locomotives.

THIS subject is still under active debate. In our April number we reviewed an article by Mr. Geo. S. Morrison in *The Railroad Gazette.* In our June number we also reviewed an editorial in the same paper (April 12), in which it was asserted that "no one has been able to show that the use of two cranks at right angles makes it impossible to prevent injury to the tracks." Others joined in the debate. Mr. Morrison's opinion that the only way to perfect a balance and thus avoid injury to track is to use four-cylinder locomotives with cranks set at 180° was attacked. In reply Mr. Morrison sent a letter to the editor of *The Railroad Gazette* (printed June 14), in which he says:

"Referring to the matter of counterbalancing, and especially to the ground that has been taken by Mr. Barnes and others, the whole matter of the effect of counterbalancing reciprocating parts by revolving parts may be briefly stated. It is impossible to counterbalance reciprocating parts in this way without introducing a vertical disturbance which materially increases the pressure on the rails over what it would be if this vertical disturbance was not introduced. It is undoubtedly possible to build a track to stand this increased vertical pressure. On the other hand, it is not economical to build such a track, and it has never yet been done. If the motive-power department wishes to build the cheapest engine possible, it is for its interests to use engines for the class now running. If the maintenance-of-way department wishes to build and maintain the cheapest track consistent with traffic, it must get rid of the disturbances now caused by counterbalancing. If the general manager of a railroad wishes to get the best results from the whole rather than from a single department, he must take these two conditions into consideration, and the result will be the use of a more expensive locomotive which will make it possible to save enormously in the cost and maintenance of track."

Upon this the editor of the paper quoted commented editorially at length, in the same issue, the subject being important, and Mr. Morrison being an eminent engineer, whose views, though at variance with those of his critics, command respect. This editorial substantially concedes Mr. Morrison's proposition that "it is impossible to counterbalance a locomotive [two-crank locomotive ?] so that there will be no vertical disturbance; but," it goes on to say:

"Whether it is or is not economical to build such a track" as will stand this disturbance, and whether it has or "has never yet been done," will remain open questions until facts are collected that show conclusively that locomotives balanced on the common plan and run at ordinary and reasonable speeds either do or do not injure the track more than will be allowed by general managers, who are bound to get the best results from the whole rather than from a single department. What is most needed now is evidence on this specific question from a track standpoint; and, until facts presented show that, under normal conditions, track is damaged seriously by locomotives, those who claim that the effect on the track can be enough reduced by proper designs of reciprocating parts will have the weight of argument on their side.

In this editorial, reference is also made to an eight-wheel 19-in. cylinder locomotive described in the issue of May 17, built at the Schenectady Locomotive Works for the Delaware and Hudson Canal Company, and it is said that this locomotive "is an example of lightened reciprocating parts that may be taken as a perfectly practical plan of construction, which, while not the lightest possible, is easily reached." It has 68-in. drive-wheels, and can run 70 miles per hour. "This locomotive will ride well, if 250 lbs. of weight is left unbalanced on each side. This amount has been determined from the practical working of a large number of locomotives of this weight. The weight of the piston, cross-head, and part of the main rod, which form the reciprocating parts, is 650 lbs. on each side. Deducting the weight that can remain unbalanced, the weight to be balanced is 400 lbs. As there are two drivers on each side, 200 lbs. of balance can be put in each wheel. If this is found to be too much, it is perfectly practicable to use six drivers for high speed; but this phase of the question can be set aside here, and the condition of the four-coupled locomotive examined as being more in accord with present practice.

"The locomotive for which these parts were designed has a 68-in. wheel, and therefore is intended for speeds up to 70 miles an hour. Larger wheels are used for higher speeds, while the cylinders and the reciprocating parts remain the same. With a 7-ft. wheel this locomotive might be expected to run at 90 miles an hour. The crank-pin velocity at 70 miles an hour, with the 68-in. wheel, is 36 ft. per second. The centrifugal force of 200 lbs., revolving at 1-foot radius, at these speeds, is 8100 lbs. for the 68-in. wheel at 70 miles an hour, and 8900 lbs. for the 84-in. wheel at 90 miles an hour. If two drivers only were used, the centrifugal forces would be about twice as much, and, if six drivers were used, the forces would be but two-thirds as much. If the locomotive is compound, the centrifugal force must be much higher. Thus the disputants have a basis to work on, and the argument can proceed without waiting for further facts so far as the locomotive is concerned. It is possible to decrease the weight of the reciprocating parts still further, but not enough so as to materially affect the figures here given.

"It now remains to be settled whether these forces will injure the track, and we shall hope that some of our readers who are trackmen will take this up. So far little of value has been published or said about the actual effect on the track of the centrifugal force of the 'excess balance' when the wheel does not lift from the rail. In this specific case the weight on the rail is about 21,000 lbs. per driver, and therefore the wheels will not lift."

The editorial having been submitted to Mr. Morrison, he makes the following replication in the same issue:

"It is undoubtedly possible to greatly reduce the effect of the excess balance in wheels, but it cannot be eliminated. A man may break his bones by tumbling out of a third-story window. He may be in the habit of tumbling out of a second-story window without breaking his bones; at the same time his bones are subject to a greater risk if he is in the habit of tumbling out of that second-story window than if he is in the habit of quietly going down the stairs. It may also be reasonably expected that his life will be shorter from such eccentric conduct, though it would be impossible to determine how much shorter it would be. It may be impossible to measure what the injury done to rails by moderate excess counterbalancing is; this does not alter the fact that they are injured and worn more rapidly than is necessary."

The debate is getting to be interesting. The outcome of it will be that the question of the effect of the locomotive upon the track will be brought nearer to settlement, and the possibility of so balancing a two-cylinder locomotive, not so that all vertical disturbance will be eliminated, but so far as to render the injury slight and tolerable, will be either determined or disproved.

Inspection of Steel-Tired Wheels.

At the meeting of the New York Railway Club held May 16, 1895, Mr. Samuel Higgins, superintendent of motive power on the Lehigh Valley Railroad, and a member of the executive committee of the club, opened a discussion by a paper entitled: "What is the Best Way to Inspect Steel-Tired Wheels under Passenger Cars During Time Allowed at Stations?" He stated that on the Lehigh Valley Railroad there were about ten thousand such wheels, consisting of "a cast-iron center, to which the steel tire is welded." He presumed that all the members of the club would concede the importance of such inspection, upon which the safety of high-speed passenger trains largely depends; and the first requirement for efficient inspection is to obtain good, bright inspectors. "Starting with a good, bright inspector, the next thing to be considered is: How shall this man do the work so as to get the best results during the limited time allowed for such work while trains are standing at stations? Assuming that the inspection is to be made under the most unfavorable circumstances, which I think would be after dark, is it best to provide the inspector with a good torch and a hammer for tapping the wheels?" Or, instead of a hammer, should he have a "suitable wrench for tightening up any nuts that he may find to be loose?"

From his own experience Mr. Higgins preferred the wrench, as he thought an inspector can do better work with it than with the hammer; and in his opinion the inspector ought to be instructed to inspect the inside as well as the outside faces of the wheels. He thought a careful man would detect more defects in this way than by using a hammer. He had frequently noticed inspectors tapping wheels in a most perfunctory manner, depending almost wholly on sound, and making little or no other examination.

"Several months ago one of our inspectors detected a steel-tired wheel having a defective tire, which defect was discovered by the eye and not with the hammer. The wheels were removed, and, as some of the officials of our road rather questioned the advisability of not making the hammer test, several parties were asked to take the hammer and tap the wheels as they stood mounted on the axle, not knowing which wheel was defective. Each person who tried the wheels with the hammer pronounced that the good wheel was the one with the defective tire, whereas they all thought that the wheel which had the defective tire was sound, which goes to show what chances we are taking if we depend upon the hammer test."

"Some may argue that, in addition to a close inspection by the eye of such wheels, the hammer test should be also made; but, if this is done, the inspector must dispense with carrying the wrench, and in my opinion the wrench and a good torch is a better combination than the hammer and a torch. There are many defects to which wheels are liable that the hammer test has nothing to do with, such as sharp flanges, flat spoons, etc.; which is another argument in favor of giving the wheels a close inspection with the eye rather than merely tapping them with a hammer; and, as stated before, if our inspectors are provided with hammers, they are more than liable to merely tap the wheels, and, if they sound all right, pay no further attention to them."

A lively discussion followed the reading. All who are reported as taking part in it concurred in the opinion that eyesight inspection is preferable to the sound test. In the course of the discussion it was brought out that steel-tired wheels are less liable to flat with a given braking power than cast iron, and that previous to the use of power-brakes a flat on a steel wheel was a rare thing.

Weight Per Square Inch on Car-Journals.

MR. E. W. GRIEVES has written a very interesting letter to the editor of *The Railroad Car Journal*, referring to an editorial in the March number of that publication upon the above-named subject. In this letter he states that he "recently had occasion to make some inquiries as to the practice pursued by other car builders, for the purpose of comparison; and, as the correspondence contains some information which will probably prove of interest," he sends it "for publication." Following is a copy of a circular letter he addressed to a number of heads of the mechanical departments of various railroads:

"Will you kindly advise me, for my personal information, how many pounds per square inch you calculate to carry on a car-journal? For instance, my mode of calculating this would be as follows: Take the light weight of the car, deduct the weight of the wheels and axles, add to the result the capacity of the car, and divide this by 8, to get the weight carried on each journal; and then divide that by the number of square inches in the bearing surface of the journal, multiplying the diameter by the length. I usually, in this calculation, take the full diameter of the journal, for the reason that, if the bearing is well worn, it rides very near the center of the journal."

Answers to this inquiry are communicated as of interest to railroad men.

(1) "In figuring number of pounds per square inch on a car-journal, we use as a basis the actual bearing surface, and not the area of the journal. From inspection of the different brasses, I find that the bearing surface of a brass seldom, if ever, increases with the wear after the brass has once become fairly seated."

(2) "Our heaviest regular freight-car weighs 32,300 lbs., including trucks, and is permitted to carry a maximum lading of 66,000 lbs., of which 6000 lbs. is the permissible excess load. Our journals are 4 in. diameter by 8 in. long. We do not, however, consider it safe to take the projected area of these dimensions as the bearing surface, and as a basis on which to figure the load per square inch of a journal surface, for the reason that, when new, the actual projected area is very much less, and it is clearly the minimum projected area which is most dangerous. The projected surface on the brass is 7½ in. long by $3\frac{7}{16}$ in. wide, giving the area, approximately, 25½ sq. in. The wheels and axles weigh very nearly 6300 lbs. The actual weight coming upon the journal is, therefore, 92,000 lbs., or 11,500 lbs. upon each journal, which, divided by the projected area of each brass, gives the maximum load per square inch of bearing surface a little less than 451 lbs. It is true that, as the brass wears, the journal imbeds itself deeper into it, but the length of the brass is diminished in the course of time by end wear, which may or may not compensate for the increased width of the bearing. Again, the journal becomes reduced in diameter, and in the later stages of its existence, before it is removed, it may be down to very nearly 3¾ in., and the brass may again be worn to a considerable amount at the ends. The safe measurement is, therefore, I think, that obtained from measuring the projection of the surfaces in contact when the brass and axle are new."

(3) "The weight of our heaviest cars, when loaded to their full capacity, which are our 60,000-lb. capacity furniture cars, is 335 lbs. to the square inch on the axle. Our 60,000-lb. capacity box-cars carry 320 lbs. to the square inch. We arrived at the weight in the same manner that you do. We are having very little trouble with these cars."

(4) "The maximum load on our car-journal is, with our 30-ton loaded car, when we have 90,000 lbs. on eight journals, each having a bearing surface of 7 5/8 × 4=30 sq. in.

" $\frac{90{,}000}{8 \times 30}=375$ lbs. per sq. in. We think 4 in. wide is ample to count on, as but little pressure comes on the side when the bearing is badly worn. The full weight of the car and load should be taken, as the bearing is seldom on the whole surface, and the reduction of weight of wheels and axles is small compared with the increase in pressure per square inch due to the reduced bearing surface under which bearings are liable to run. With the full load and full surface, however, the pressure per square inch on freight-cars is 375 lbs., as given above. If the brass had a bearing on but half of its proper surface, the pressure per square inch would be 750 lbs. Our mechanical engineer says: 'With 33-in. wheels and at 60 miles per hour, the speed is six hundred revolutions per minute; four hundred for 40 miles per hour,—a high average for freight-cars. In tests of bronze bearings at speeds of 500 revolutions per minute, the temperature increases rapidly when the pressure exceeds 450 lbs. per square inch.' He is of the opinion that 400 lbs. is the maximum which should ever be reached, and we concur with him in this opinion."

(5) "I have never made any previous calculations in regard to the weight per square inch of sectional area of journals that we are carrying on our cars. If I were going to figure it, I should do it in the same manner that you have stated. I find that the severest load per square inch

on that basis that we are carrying is in our 50,000-lbs. capacity drop-bottom coal-cars, which have 3¾ × 7 in. journals; these are carrying a load of 342 lbs. per square inch of sectional area. The heaviest load per square inch that we have with 4¼ × 8 in. journals is in our 40-ft. furniture-cars, which have a load of 306 lbs. per square inch. In the case of the drop-bottom coal-cars, would say that we have box-cars weighing a little more than the coal-cars, which had the same rating—50,000 lbs. capacity—and had the same—3¾ × 7-in.—journals. I found we had so many journals burned off on these cars that it was necessary to lower the rating to 45,000 lbs., and recommended having the same change made on the coal-cars, but it was not approved by the general manager. Of course, in actual service, where a new journal bearing is applied to a journal, the entire weight is distributed in a strip not over 1 in. wide the entire length of the journal. As the brass wears down, the size of the bearing surface increases, but, when it first commences, there must be something like 1200 lbs. to the square inch on the bearing surface."

(6) "I think it difficult to say just how much we carry on each journal, because a car marked for 60,000 lbs. may and does have sometimes much more on it. I saw a car only a few days ago that had journals only 3¾×7 in. That was weighed with the load, and its weight was 123,000 lbs. The car weight light was about 23,000 lbs., having 100,000 lbs. for a load on a smaller journal than we use for 60,000 lbs. load; but, as to the manner of getting at the weight per square inch, you are right, except I do not think you should take the full diameter of the journal; while I admit, if the bearing is worn, it will cover about one-half of the journal, or extend down to the center; but the weight, I conclude, is only on about one-third of the journal. So I take our own thus: weight of wheels and axles, about 6400 lbs., leaves on journal 20,600 + 60,000 = 80,600 lbs. on the eight journals; on one, 10,075 lbs. I think our brasses, 4½ × 7½ in., have not far from 26 in. bearing surface, which would bring about 388 lbs. per square inch. This is what I calculate is on ours when loaded with 60,000 lbs."

Some of the replies show a distrust of projected area of journals as a basis for computing weight permissible on axle-bearings; and it may be that for bearings in other kinds of machinery this basis is misleading. From the data thus supplied Mr. Grieves has compiled a table which accompanies his letter in *The Railroad Car Journal*, and which may probably be relied upon as representing average American practice.

THE RAILROAD GAZETTE says, speaking of a letter from the Interstate Commerce Commission warning railroad officers not to assume that illegal contracts become legal by being filed with the commission, attributes it to the fact that the Central Traffic Association neglected to reply to a request for a copy of an eastbound freight contract. Commissioner Blanchard sent to Washington the proceedings of the meeting of April 9, in which the roads voted that "the Commissioners of the Central Traffic Association have power to even up the Chicago roads that are deficient in their tonnage by withdrawing the roads that are over from soliciting in the market, and by the transfer of freight to the deficient roads when practicable, the lines in deficit to receive and forward the said tonnage." This implied some agreement as to what basis the tonnage should be evened up to, and the Commission asked for a copy of this agreement, but it was not forthcoming. The working of this interstate commerce law appears to be developing far too much friction for a well-designed machine.

Street Railway Statistics.

THE table on the next page which we reproduce from *The Street Railway Journal* for July is claimed by the editors of that enterprising publication to be the most complete, as relates to mileage, cars, and capitalization, that has yet appeared Commenting editorially upon it, they assert their belief that the mileage may be considered accurate within 5 per cent. for all States except Pennsylvania; and that

STREET RAILWAY STATISTICS OF THE UNITED STATES.

TABLE I.—MILEAGE, CARS, CAPITAL STOCK AND FUNDED DEBT.

STATES.	No. of Roads.	MILES OF TRACK.					NO. OF CARS.		CAPITAL STOCK.		FUNDED DEBT.		CAPITAL LIABILITIES.	
		Horse.	Electric.	Cable.	Miscel.	Total.	Total.	Per mile track.	Total.	Per mile track.	Total	Per mile track.	Total	Per mile track.
New England.														
Maine	11	28	63			91	198	2.16	1,889,925	20,600	1,546,000	16,900	3,435,925	37,5
New Hampshire	5	27	27			54	121	2.28	475,000	8,900	360,000	6,800	835,000	15,7
Vermont	2		14			14	31	2.15	285,000	19,800	195,000	13,500	480,000	33.3
Massachusetts	54	77	892			969	3,896	4.02	31,611,375	32,600	23,020,000	23,700	54,631,375	56,3
Rhode Island	9	3	155			158	520	3.29	11,604,500	73,400	11,608,000	73.400	23,212,500	146,8
Connecticut	23	33	241			274	753	2.75	7,912,500	28,800	6,817,000	24,900	14,729,500	53,7
Total	104	168	1,392			1,560	5,519	3.54	53,778,300	34,500	43,546,000	27,900	97,324,300	62,4
Eastern States.														
New York	[illegible]	353	1,020	46	164	1,583	9,115	5.76	176,176,723	111,200	153,131,445	96,700	329,308,168	207,1
New Jersey	36	53	418		2	473	826	1.75	31,908,750	67,600	29,189,500	61,800	61,098,250	129,4
Pennsylvania	124	48	1,304	62	8	1,422	4,021	2.82	116,293,850	81,700	42,307,560	29,700	158,601,410	111,5
Delaware	3		26			26	64	2.49	358,000	13,900	600,000	23,300	958,000	37,2
District of Columbia	11	63	52	28		143	927	6.49	4,615,500	32,300	7,220,000	50,600	11,835,500	82,9
Maryland	11	24	205	21	2	252	668	2.66	12,845,000	51,100	12,967,000	51,600	25,812,000	102,6
Virginia	16	16	134		4	154	290	1.89	4,656,250	30,400	3,221,000	21,000	7,877,250	51,4
West Virginia	6	10	30		9	49	90	1.88	1,340,000	27,900	682,000	14,200	2,022,000	42,10
Total	[illegible]	567	3,189	157	189	4,102	16,001	3.90	348,194,073	84,900	249,318,505	60,800	597,512,578	145.70
Central States.														
Michigan	20	60	272		9	341	1,006	2.95	6,581,200	19,300	8,089,000	23,700	14,670,200	43,10
Ohio	63	58	972	43	4	1,077	3,254	3.02	51,942,250	48,200	22,334,500	20,700	74,276,750	68,90
Indiana	21	25	297		8	330	755	2.29	9,363,550	28,400	7,470,000	22,600	16,833,550	51,00
Kentucky	11	59	147			206	625	3.03	7,496,900	36,400	6,530,000	31,700	14,026,900	68,10
Wisconsin	18	20	249		12	281	472	1.68	7,720,000	27,400	13,187,000	46,900	20,907,000	74,30
Illinois	40	267	520	86	69	951	5,815	6.12	66,213,025	69,600	55,918,000	58,800	122,131,025	128,50
Minnesota	14	11	516	13		540	1,995	3.69	29,274,000	54,200	26,863,000	49,700	56,137,000	103,90
Iowa	24	18	210	7	8	243	401	1.90	8,216,100	33,800	4,806,000	19,800	13,022,100	53,60
Missouri	48	37	386	103	24	550	2,553	4.64	35,834,000	65,100	28,370,000	51,600	64,204,000	116,70
Total	[illegible]	555	3,578	252	134	4,519	16,876	3.74	222,641,025	49,300	173,567,500	38,400	396,208,525	87,70
Southern States.														
North Carolina	11	4	37		4	45	81	1.82	911,700	20,500	855,000	19,200	1,766,700	39,60
South Carolina	6	36	10			46	103	2.25	462,000	10,100	296,000	6,500	758,000	16,60
Georgia	19	21	246		14	281	402	1.42	4,931,000	17,500	5,085,500	18,100	10,016,500	35,60
Florida	7	24	11			35	124	3.57	362,500	10,400	4,600	100	367,100	10,50
Alabama	20	27	70		120	223	311	1.40	5,809,800	26,100	2,650,000	11,900	8,459,800	38,10
Mississippi	6	21			2	23	60	2.67	215,000	9,600	16,500	700	231,500	10,30
Tennessee	23	16	178	6	67	267	473	1.77	6,262,000	23,500	4,854,600	18,200	11,116,600	41,60
Louisiana	12	36	159			195	226	1.16	13,286,350	68,100	8,838,000	45,300	22,124,350	113,40
Arkansas	7	29	32			61	150	2.46	915,375	15,000	978,700	16,100	1,894,075	31,10
Total	111	214	743	6	213	1,176	1,930	1.64	33,155,725	28,200	23,578,900	20,100	56,734,625	48,20
Western States.														
South Dakota	6	17	11		7	35	21	.60	350,000	10,000	75,000	2,100	425,000	12,100
Nebraska	13	58	160			218	464	2.12	8,652,500	39,700	3,760,000	17,200	12,412,500	56,900
Kansas	12	36	83		11	130	185	1.43	3,720,000	28,700	2,785,000	21,500	6,505,000	50,200
Texas	49	81	242		24	347	531	1.53	6,759,001	19,400	5,421,000	15,600	12,180,601	35,100
Colorado	13	8	230	8	15	261	638	2.44	9,920,000	38,000	10,130,000	38,800	20,050,000	76,800
Montana	4		52	2	2	56	69	1.25	1,700,000	30,800	1,250,000	22,700	2,950,000	53,500
Idaho	1		3			3	2	.67	53,300	17,800			53,300	17,800
Utah	4		90		6	96	120	1.25	1,800,000	18,800	1,400,000	14,600	3,200,000	33,400
Washington	23	7	187	18	4	216	244	1.13	9,862,000	45,700	5,414,000	25,100	15,276,000	70,800
Oregon	12	7	[illegible]	7	24	136	218	1.60	2,451,000	18,000	2,735,000	20,100	5,186,000	38,100
California	52	[illegible]	317	[illegible]	[illegible]	732	1,887	2.57	44,977,282	61,400	29,144,000	39,800	74,121,282	101,100
Total	[illegible]	410	1,471	217	143	2,231	4,359	1.95	90,245,083	40,300	62,114,600	27,700	152,359,683	68,000
United States.	976	1,914	10,363	632	679	13,588	44,745	3.29	748,014,206	55,000	552,125,505	40,600	1,300,139,711	95,600
Canada.	32	43	389			432	1,011	2.34	14,317,800	33,200	4,475,000	10,400	187,92,800	43,500

even in that State, wherein extensions and new constructions are very active, the error will fall within 10 per cent. The capitalization is also thought to be correct within 10 per cent., and in most of the States within 5 per cent.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

*32400. The Trolley in Competition with Railroads.—An Interesting Situation in Connecticut. Clarence Deming (Eng Mag-Aug.) 4000 w.

32437. Conduit Railways. Ill. Max J. Levy (Elec Age-June 8.) 1800 w.

32440. Electric Railways and Tramways in Great Britain. Albert H. Bridge (St R'y Gaz-June 8.) 1000 w.

32444. The Need of Uniformity in Car Construction. Editorial (R'y Mas Mech-June.) 800 w.

32445. The Discipline of Employés. (Extract) William Gibson (R'y Mas Mech-June.) 1600 w.

32446. The Locomotive Testing Plant of the Chicago and Northwestern Railway. Ill. (R'y Mas Mech-June.) 1400 w.

32447. A Simple and Short Method of Producing Power Diagrams. Theodore H. Curtis (R'y Mas Mech-June.) 2200 w.

32452. Railway Enterprise in Egypt. Frederic C. Penfield (Elec Rev-June 12.) 450 w.

32453. Car Service. Report of Committee of the Am. R'y Asso., with Editorial (R'y Rev-June 8.) 3000 w.

*32471. The Crampton Locomotive. Ill. W. B. Paley (*R'y Wld*-June.) 1600 w.

*32472. The First Inside Cylinder Locomotive. G. A. Sekon (*R'y Wld*-June.) 1800 w.

†32493. The Railroad in Asia. Charles Morris (New Sci Rev-Jan.) 6000 w.

†32501. Railroad Facts and Figures. Melville Phillips (New Sci Rev-April.) 2700 w.

32511. Trolleyizing the Nantasket Beach Railroad. Ill. (R R Gaz-June 14.) 1800 w.

32512. Pooling Locomotives. F. R. Foster (R R Gaz-June 14.) 2200 w.

32513. Separation of Grades on the N. Y., N. H. & H. R. R. in Boston. Ill. (R R Gaz-June 14) 2000 w.

32514. English Block Signal Rules. (R R Gaz-June 14.) 1700 w.

32515. Classification of Passenger Traffic in England. C. H. Grinling (R R Gaz-June 14.) 2500 w.

32516. An Important Mexican Railroad Contract—The Tehuantepec Railroad (Mfr Rec-June 14.) 900 w.

32531. Tank Locomotives and the Brooklyn Bridge. Ill. (Eng News-June 13.) 600 w.

32535. American and French Four-Cylinder Compound Freight Locomotives. Ill. (Eng News-June 13) 1100 w.

*32567. Brakes for Light Railways—From Report of M. Plocq (*Engng*-June 7.) 3800 w.

*32584. The Effect of Negative Lead on Locomotives. Ill. (*Mech Wld*-June 7.) 1600 w.

32615. Reports of Committees at the Master Car Builders' Convention, with Editorial. (Ry Rev-June 15.) 10700 w.

32656. Electricity or Steam? H. G. Prout, in New York Independent (Elec Eng-June 19.) 3500 w.

*32661. The Inter-Continental Railway. Ill. Dion Martinez (Stone-June.) 1300 w.

*32665. Price Hill at Cincinnati. Ill. (St R'y Rev-June.) 700 w.

*32666. The Inter-Urban Electric Railway. (Abstract.) Ill. S. H. Short (St R'y Rev-June.) 2500 w.

*32667. A Model Inter-Urban Car. Ill. W. E. Haycox (St R'y Rev-June.) 600 w.

32683. A Great Railroad Move.—Southern Railway Co. to Go into Norfolk. D. Allen Willey (Mfrs Rec-June 21.) 1600 w.

32684. The Tehuantepec Railroad. A Great Opportunity for American Contractors (Mfrs Rec-June 21.) 1800 w.

32690. The Master Car Builders' Laboratory Tests of Brake Shoes (Eng News-June 20.) 2200 w.

32694. The Chicago Plan of Interchange at the M. C. B. Convention. Editorial (Eng News-June 20.) 2400 w.

32696. Belt Line Power Station and Equipment. Ill. Louis Duncan (Elec Age-June 22.) 1000 w.

32698. Trolley Currents and Automatic Signals. G. N. Thayer (Elec Age-June 22.) 700 w.

*32708. Workmen's Trains. Editorial *Engng*-June 14.) 2200 w.

(*32720. The Gare de Sceaux Central Station. Ill. Emile Dieudonné (*Elect'n*-June 14.) 2600 w.

32741. Accumulators on Electric Railroads. Ill. (West Elec-June 22.) 1200 w.

32776. Bridges for Elevation of Tracks on Chicago, Rock Island & Pacific, and Lake Shore and Michigan Southern Railways in Chicago. Ill. (Ry Rev-June 22.) 1700 w.

32777. Safe Speed of Trains at Interlocked Grade Crossings. W. J. Gillingham, Jr. (Ry Rev-June 22.) 1000 w.

32779. What Is the Best Way to Inspect Steel-Tired Wheels Under Passenger Cars During Time Allowed at Stations. Mr. Higgins, with Discussion. Paper read at N. Y. Railroad Club. 2800 w.

32807. The Boston Electric Railway Subway. Ill. (Sci Am Sup-June 29.) 900 w.

32817. Why the Free Time in New England

Is Ninety-six Hours. E. A. Gordon (R R Gaz–June 28.) 700 w.

*32825. The Relation of Railroad Transportation to Production in California. R. L. Dunn, with Discussion (Jour As Eng Soc–May.) 10000 w.

*32827. The Abolition of Grade Crossings Between Railroads and Highways. I. The Gradual Abolition of Highway Grade Crossings. Augustus W. Locke II. Abolition of Grade Crossings. James W. Rollins, Jr. III. Abolition of Grade Crossings in the City of Brockton. a. F. Herbert Snow. b. James W. Rollins, Jr. (Jour As Eng Soc–May.) 11500 w.

*32828. Abolition of Grade Crossings on the Providence Division of the Old Colony Railroad in Boston. James W. Rollins, Jr., with Discussion (Jour As Eng Soc–May.) 5500 w.

32852. Electric Railway Lines of the Chicago City Railway Company. Ill. Abstract from Chicago Sunday Tribune (W Elec–June 29.) 2000 w.

*32882. The Railway Congress (*Eng*–June 21.) 6200 w.

*32922. The Working of Belgian Vicinal Railways. Anon. (*Jour Soc of Arts*–June 21) 1900 w.

†32954. A Cause and Remedy for Sharp Flanges. Ill. C. F. Ubelacker (St Ry Jour–July.) 600 w.

†32956. Can Electricity Compete with Steam. Editorial (St Ry Jour–July.) 1800 w.

†32957. The Electric Locomotives of the Baltimore and Ohio Railroad (St Ry Jour–July.) 4800 w.

†32958. Electric Car Trucks. Ill. William Robinson (St Ry Jour–July.) 1800 w.

†32959. Street Railway Statistics of the United States (St Ry Jour–July.) Table.

32969. Discipline. W. M. Duane (Ry Rev–June 29.) 500 w.

32982. Elevated Railroads in Chicago. Editorial (Ry Age–June 28.) 1100 w.

†32985. Railway Extension in India. H. (*Ind Engng*-June 1.) 800 w.

*32989. The International Railway Congress. Editorial (*Trans*–June 28.) 2500 w.

*32992. Economy of Locomotive Working and Maintenance. R. Price-Williams (*Eng Rev*–June 20.) 2200 w.

*32993. Development of the Crewe System of Compounding Locomotives. Ill. F. W. Webb (*Eng Rev*–June 20.) 1000 w.

*32994. English Wagons and American Bogie Trucks. John A. F. Aspinall (*Eng Rev*–June 20.) 1000 w.

*32995. The Influence of Patent Law on Railway Progress. W. Lloyd Wise (*Eng Rev*-June 20.) 2500 w.

*32996. The Development of the Locomotive. Ill. (*Eng Rev*–June 20.) 500 w.

*32997. Railway Brakes. Lucien Serraillier (*Eng Rev*-June 20.) 2500 w.

*32998. The Railway Rate Problem (*Eng Rev*–June 20.) 1300 w.

*32999. Electric Locomotives and Railways. Ill. (*Eng Rev*–June 20.) 3000 w.

*33000. On the Recent Progress of Permanent Way (*Eng Rev*–June 20.) 3800 w.

*33001. The Trans-Siberian Railway (*Eng Rev*–June 20.) 1600 w.

*33003. Great Mountain Railways. John Harrison Means and John C. Branner (Chau–July.) 6000 w.

*33036. Indian Railway Development. Editorial (*Engng*-June 28.) 1600 w.

*33044. Speed Regulation of Electric Motor Cars. Philip Dawson (*Elec Rev*–June 28.) 800 w.

Serials.

24586. Railway Companies and Their Employés. O. D. Ashley (Ry Age–Began Aug. 24, 1894—13 parts to date—15 cts. each).

24741. Special Shop Tools. Ill. (Ry Mas Mech–Began Sept., 1894—3 parts to date—15 cts. each).

25670. Painting a Railway Passenger Car. A. Ashmun Kelly (Ry Mas Mech–Began Oct., 1894—6 parts to date—15 cts. each).

28138. Block Signaling. Ill. W. H. Elliott (Loc Engng–Began Jan.—7 parts to date—30 cts. each).

28496. Electric Traction. Ill. Philip Dawson (*Engng*–Began Jan. 4—22 parts to date—30 cts. each).

29369. Tramway Management. By a Manager (*Ry Wld*–Began Feb.—5 parts to date—30 cts. each).

29840. Travels of the World's Transportation Commission. Clement F. Street (Ry Rev–Began March 2—3 parts to date—15 cts. each).

30604. Locomotive Repair Shop Equipment. W. H. Weston (Nat Car & Loc Build–Began April—4 parts to date—30 cts. each).

30654. Street Railway Repair Shops. Ill. Henry P. Merriam (St Ry Jour–Began April—4 parts to date—45 cts. each).

31738. Compressed Air Motors for Tramway Traction. Ill. H. Conradi (*Ry Wld*–Began May—2 parts to date—30 cts. each).

32562. Belgian Railways (*Engng*–Began June 7—1 part to date—30 cts).

32668. Vestibule Equipment. Ill. (St Ry Rev–Began June—1 part to date—30 cts).

32711. Express Locomotives. John A. F. Aspinall (*Eng*–Began June 14—Ended June 28—3 parts—30 cts. each).

32749. Effect of Temperature on the Strength of Railway Axles. Ill. Thomas Andrews (*Ind & Ir*–Began June 14—1 part to date—30 cts).

33002. The Past and Future of Railway Construction in the United States. Edward Atkinson (*Eng Rev*–Began June 20—1 part to date—30 cts).

33056. A Method of Electric Traction for Tramways in Towns.—The Thwaite-Cawley System (*Elec Eng*–Began June 28—1 part to date—30 cts).

SCIENTIFIC MISCELLANY

Pitch Lake of Trinidad.

Mr. S. F. Peckham, in *American Journal of Science* for July, gives a very interesting description of this remarkable deposit. He finds that previous descriptions of it given 40 to 100 years ago are in the main correct, so far as they extend. The pitch in this lake, though apparently solid, is in reality in a state of very slow ebullition. Mr. N. S. Manross, writing of it in 1855, says : "As the descent of the glacier may be considered the slowest instance of flowing in nature, so the revolutions of the scarcely less solid bitumen of this lake may be set down as the slowest example of ebullition."

In 1892, Hon. W. P. Pierce, United States consul at Port of Spain, made a very full and able report upon the asphalt of Trinidad, this report having been followed by another by Mr. Clifford Richardson, at that time inspector of asphalt and cement for the District of Columbia. The latter differed materially from that of Mr. Pierce in statements and conclusions, and Mr. Peckham explains that it was for the purpose of satisfying himself as to the facts that he visited the lake. The following is an abstract of Mr. Peckham's paper.

On approaching Point La Brea from the northwest, the reef of asphaltum that forms a barrier around the point and against the sea is plainly visible. Upon the point itself, and jutting into the sea, are what appear like low ledges of rock, which a nearer inspection proved to be masses of asphalt taken from village lots that had been piled for shipment, but had been so long left in the tropical sun that they had melted and flowed into a solid homogeneous mass looking at a short distance, like ledges of slate. The piles, which were originally about 25 ft. in height, were not more than 3 ft. thick. Near these masses were other piles of the same material, from which lighters were being loaded, and which had not remained in the sun long enough to melt. Many hundreds of tons were included in these masses, the original pieces of which had so far coalesced that the asphalt had to be again broken with a pick before removal.

"Passing on shore and beyond these piles, the plant of the pitch lake *concessionaires* was encountered, in which the operation of boiling a mixture of so-called land asphalt, the ordinary lake asphalt, and the soft pitch from the center of the lake was going forward. The operation is conducted in kettles, resembling open sugar kettles, and is a very crude and simple operation. Passing eastward, I next encountered a wide area covered with asphalt that had melted in the sun to a level surface perhaps 2 ft. in depth. I was told that this asphalt was dug from a village lot, the ownership of which was in dispute; that originally the piles were at least 20 ft. in height, but, while the owners disputed, the piles melted in the sun.

"Farther on I struck the road to the lake, which appeared to me exactly as Mr. Manross had described it 40 years ago. The houses in the village were in the same condition described by Dr. Nugent in 1807. The slope leading up to the lake was in exactly the condition in which all previous observers had described it, as resembling a lava flow—a black glacier. The several points at which asphalt had been and was being excavated showed in the most admirable manner that the movement of the asphalt down the slope and towards the sea is still in progress. Every excavation was in a short time partially refilled by a movement of the asphalt up from the bottom and in from the sides, the cavity in time becoming filled full to the level of the surrounding area. One illustration of this fact was the spot from which the noted cargo of the Teneriffe was taken, every trace of former excavation having completely disappeared.*

---

*"I was told by those who witnessed the digging of this cargo that apparently no care was exercised in its selection. One gentleman declared that it was the dirtiest cargo of pitch ever sent from the island."

"The Trinidad Bituminous Asphalt Company were excavating a lot near the road, and had also recently uncovered a lot that had become almost completely refilled in a few months, after the removal of several thousand tons of asphalt. Farther up the slope the Trinidad Asphalt Company were taking out asphalt from lots on the Belle Vue estate. These lots, like most of the others, were covered with a dense tropical jungle, consisting of palms, sedges, canna, and other plants, from 3 to 10 ft. in height. It did not need the testimony of Mr. Manross to show that, in all probability, fire had more than once consumed this mass of vegetation, producing a terrific heat that had melted and converted into so-called 'iron pitch' much of the surface of the pitch. The 'iron-pitch' is present in greater or less quantity, both within and without the boundaries of the lake, wherever fire has consumed the vegetation, and consists simply of melted pitch which has been heated so hot as to deprive it of its water and more volatile constituents, causing it to flow in streams, often to considerable distances. Below these melted masses the pitch lies in its normal and unaltered condition.

"It must, however, be constantly borne in mind, while reading the statements of different observers made on different occasions, that the lake and its principal overflow have presented different phenomena at different periods. While it was evident at the time I visited the overflow that fire had swept over the surface, it was equally evident that it had for a long time been free from any such visitation. I have seen similar flood-plains of asphalt in California that had been on fire for months, and others that had been burned some time previous to my visit to them. I can imagine that, after such a fire, the resemblance of the overflow of the lake to a 'black glacier' would be much more pronounced than when covered with a rank growth of vegetation, as it now is. It is not, however, the surface that flows, covered, as it is, by masses of coke, iron-pitch, vegetation, and rubbish. The houses in La Brea now all rest on blocks. In this position they are much more stable than on posts, although anything resting upon the overflow is unstable. It is the cheese-pitch, full of water and containing more or less gas, buried beneath these surface accidents, that has flowed and still flows.

"Although a large amount of clay and vegetable *débris* fills the interstitial spaces of the rough surface of the asphalt, the vegetation is not confined to such surfaces, but seems to flourish equally well upon the bare pitch, the roots penetrating the pitch without the slightest difficulty, except where it had been converted by melting into iron-pitch. There is also considerable coke where the fires have been hottest. All of these impurities are carefully excluded from the pitch that is mined, both for boiling and for shipment in the crude state, by all of the men employed by the different companies in extracting it. This selection is not difficult, as the appearance of the iron-pitch is very different, and the amount very small, as compared with the pure or cheese-pitch."

The appearance of the lake closely resembles that of the asphalt beds in California. Mr. Peckham thinks that the suggestion made by Mr. Richardson that "the lake occupies the crater of an old mud volcano is correct, and that it is built up of very unstable material, through contact of water issuing in large quantity from subterranean springs," carrying with it large quantities of disintegrated rock, so that the stream resembled a stream of quick sand. Into this stream the bitumen was projected, "at intervals in very large amounts, so that irruptions of mud have coincided with and alternated with irruptions of bitumen, the whole building up the cone and at times overflowing it, while the basin gradually filled with bitumen to the exclusion of mud."

Technical Research.

An editorial in *Engineering* (June 28) is a strong plea for the promotion of original research by engineering associations and scientific societies, since want of means generally makes it impracticable for individuals most competent to make such researches on their own account to do so, except in certain lines of patented or patentable inventions. Engineers in general are engaged in original research; but it is mostly "at the expense of their clients."

"Great advances in engineering practice wait more often upon details than upon principles. The conception of the compound marine engine is old enough, but it was not until a satisfactory surface condenser was produced that it became commercially possible. As long as the boiler was fed direct from the sea, 30 lbs. per square inch was the limit of practicable pressure, and compounding offered no advantage under this condition. The surface condenser, as now made, is a simple enough affair; yet it took many years to arrive at it, because neither marine engineers nor ship owners were willing to spend the necessary money over a series of comparative experiments. Occasionally a sanguine individual ventured to try one, and, when he found it unsatisfactory, he generally preferred to face the known loss of abandoning it rather than enter into a series of experiments to perfect it. The triple-expansion marine engine furnishes another example. Up to about 1881 there was scarcely an engine of this kind constructed, and after that date there were very few built of any other kind. The deterrent cause in this case was a misgiving as to the possibility of finding a satisfactory material for boilers carrying 160 lbs. to 180 lbs. pressure, and complying with the requirements of marine service. Ship-owners held back from making experiments for the benefit of the trade. For years they stuck to the compound engine, well knowing that a 20 per cent. economy was available, if only certain preliminary difficulties, by no means insuperable, could be overcome. But, naturally, no one was willing to pay for experience that would be immediately public property."

Allusion is made to unsuccessful attempts in the past to develop processes, or find practical uses for materials. These attempts progressed far enough to become a bar to the procurement of valuable patents, but not far enough to render them available. Now their further prosecution must either be at the expense of individuals who cannot expect return for the expense incurred, or at the expense of associations willing to create and devote funds for experimental work.

"Superheating furnishes a case in point. It is generally believed that we are on the verge of a revival of superheating, and that it will be successful. But in years past there was a very determined attempt to use superheated steam. Apparatus was fitted in a large number of instances, particularly on board ship, and, after extended trial, was abandoned for several reasons. First and foremost, there was the difficulty of finding a lubricant that would not decompose under the influence of very hot steam. The introduction of mineral oils and vaseline has removed that source of failure without any effort on the part of mechanics. Then there was the chance of the superheater becoming incrusted with salt carried over from the boiler with priming water. But salt in boilers is, or should be, a thing of the past, now that evaporators are so common, and thus a second source of failure has disappeared. The other difficulties were chiefly mechanical, and individually were not serious. But, taken in the aggregate, they are fairly formidable, and it is certain that they will take some time and a liberal expenditure of money to entirely overcome. As our columns have shown, attempts are now being made on a practical scale to introduce superheating. The attitude of the profession is one of expectancy; the majority are waiting to appropriate the result of other people's experiments, certain that nothing can be discovered that will furnish grounds for anything but a narrow patent."

Although professors in colleges find it to their interest to perform experimental work without a direct reward, and the debt which the engineering profession owes to such investigators is freely acknowledged, the limitations of "the powers of the technical laboratory" are pointed out. "Full-sized experiments are beyond its scope. If no other consideration intervenes, there is always expense to be considered. In spite of the constantly-rising fees charged for tuition, educational establishments share in a marked degree in that 'eternal want of pence' that troubles the greater part of humanity. The available funds have to be spread over the largest possible area, like boarding-school butter. Investigations on a really large scale can, therefore, not be attempted. There is very little chance of getting these done elsewhere in a systematic manner, if, as we have already pointed out, the results cannot be secured to the experimenter under the patent laws. One notable exception, however, is found in this country [England] to this rule. We refer to the researches undertaken by the Institution of Mechanical Engineers. On these there have been spent hundreds—possibly thousands—of pounds, and the results have been freely given to the world. The researches made by the Institution on riveting, on friction, on steam-engine economy, and on alloys, are splendid monuments of the large-mindedness of the council. We know that certain continental societies have carried out similar inquiries, but not, we believe, with the same completeness."

The American Society of Mechanical Engineers ought, in justice, to have been named in this connection. Though a young society, it has been doing noteworthy and praiseworthy work in original investigation, the evidence of which is abundant in the reports and papers presented at the recent Detroit meeting. There are other young societies that ought to have been included. Among these is the Canadian Society of Civil Engineers, which has been encouraging and doing some good experimental work. Without naming others that could well be mentioned, we incline to the belief that engineering societies, as a rule, are not as apathetic as regards original investigation as one might infer from the editorial reviewed. Nevertheless the article is timely and presents the subject in the proper light. Henceforth the bulk of this sort of work must be done by such societies, or go undone.

A Standard of Sound.

Engineering (June 14) prints a letter by Mr. Hiram S. Maxim, the famous inventor and aeronaut, which contains a novel suggestion,—to wit, that a standard unit of sound shall be adopted by the scientific world. The author thinks that "some clever experimenter, like Professor Crookes or Professor Boys, should take the matter in hand, and establish a convenient unit of sound which would be accepted by the royal society of Great Britain and the board of trade." If such a unit should be established and accepted by the two bodies named, Mr. Maxim thinks it would also be acceptable in law courts as a means of deciding many vexed questions.

"All owners of electrical plant are liable to be complained of for making a noise. Sometimes it is said that their machinery causes vibrations to the surrounding buildings or ground; then, again, that they disturb telephonic communications. Manufacturers are constantly having injunctions served on them for making too much noise, when, perhaps, as a matter of fact, the noise is not even audible to those who make the complaint. In many cases, when electrical engineers and those interested in electrical plants have visited the houses of parties who have lodged complaints against electric-light stations, it has often been found that parties making these complaints were themselves willing to swear and were ready to bring any number of witnesses to prove that the noise and jar produced were enough to drive them nearly mad, when, as a matter of fact, the jar and noise were wholly occasioned by the ordinary street traffic, and, at the very moment when they pretended to be so much annoyed, the electric-light plants have not been running at all. Owners of electric and other plants may be, and often are, served with injunctions restraining them from running their works, when, in fact, the noise complained of is less than that produced by one cab passing along the street."

Mr. Maxim gives some amusing instances illustrating this tendency of people to lodge groundless complaints. The Maxim guns are fired at Erith in a building specially designed to suppress the noise and jar; nevertheless formal complaints have been made against the firing, and on the very day when no Maxim guns were fired at all. The real noise came from Plumsted Marshes about 5 miles away, where the government have always fired their large guns, and cannot now be restrained from doing so. Another instance is cited of a large manufactory, also at Erith, which, "having a small quantity of riveting to do, went to great expense to cover everything with felt, so that no noise could escape." The neighbors, however, imagined that they heard noise, and lodged numerous complaints applying for injunctions to restrain the establishment from carrying on its business. Mr. Maxim says that the real noise issuing from the factory is not greater than that produced by "a rubber-tired bicycle."

Now, when these complaints come into court, the evidence upon which they are determined is merely that of opinion,—expert and otherwise. As a result much injustice is done. Mr. Maxim goes on to suggest lines of experiment which may lead to a satisfactory selection of a phonic unit. "I would suggest, as a starter, that a kind of phonograph should be employed, and that the record should be made on smoked glass, which could be put in a magic lantern and greatly enlarged. The amplitude and frequency of the waves would indicate the intensity of the noise produced. For example, suppose a certain record should be made of the noise of the ordinary street traffic, and then another record of the noise of both the street traffic and the disturbance or noise complained of,—the two mounted side by side and projected on a large screen would enable the judge to see at a glance how much the noise was increased by the machinery, and how much cause there was for complaint. As a standard of noise which might be shown in court, I would suggest that shot of a certain size should be dropped, say, from a height of 1 meter, onto some standardized diaphragm, and that the waves should be recorded at, say, 5 meters from the diaphragm. A record of this artificial noise could be also shown on the screen, and at the same time the actual noise recorded produced in court. For telephones a record of the vibrations set up while the machines were running should be compared with one of those set up when the machines were not running. The comparison of the two would enable the judge—or the jury—to see exactly what the increase in noise actually was." In conclusion, Mr. Maxim intimates that his purpose has been merely to suggest that a phonic unit is needed, and to show that the suggestion can be carried out.

"Honor to Whom Honor is Due."

MANY newspapers have recently noticed the action of the University of Wisconsin in conferring the honorary degree of LL.D. upon each of the well-known and justly-celebrated engineers, Mr. Edwin R. Reynolds of Milwaukee, Wis., the designer and builder of the Reynolds Corliss engine, and Mr. Don J. Whittemore of Milwaukee, Wis., chief engineer of the Chicago, Milwaukee & St. Paul Railway. Both these men have achieved national reputation in their respective fields of engineering, and both have well merited the honor conferred.

In commenting upon this action of the university, the papers announcing it have mostly missed its true significance. The action means that no longer, as heretofore, are institutions of learning going to confine their honors to those who have achieved eminence in the so-called learned professions, in statesmanship, in science, and in literary work. It means an extension of the application of the word "*learned*" to the engineering profession in all its departments,—the recognition of the fact that in any of these branches eminent achievement implies superior acquirements and superior ability (whether attained in the schools or out of them), as much as, or more than, in law, medicine, or theology, and that the old convention which has hitherto restricted the application of this term to the professions named is melting away in the broader intellectual horizon over which is dawning the morning of the twentieth century.

We believe the time is coming when the engineering profession will take rank with, if not precedence of, the professions which from medieval times have been considered most honorable; and we regard the signs of this tendency as the most hopeful of indications. The period in which this recognition will be fully achieved will, however, be hastened or retarded by the action of engineers and their associations. These should now press their claims to such recognition. It is easy to show that engineering requires of its adepts an amount of learning and preparation, as well as a natural fitness, in no wise inferior to those possessed by the most shining lights in other professions. Though the preparation is of a different nature, its effect upon the general culture of the man who pursues the course of study comprised in it is as potent as that of the classical course hitherto supposed necessary to the development of the finer qualities of mind and character.

The Production and Uses of Cotton-Seed Oil.

AN abstract of an article by P. L. Simmons, F. L. S., in *American Journal of Pharmacy* and reprinted in *Scientific American Supplement* (June 8) is given in this review. The author claims the merit of being the first to suggest the production of cotton-seed oil, in a lecture delivered 40 years ago before the Society of Arts and Manufactures in London, of which lecture "The Utilization of Waste Products" was the theme.

"At the time this suggestion was made, of utilizing cotton seed for oil, in 1855, the United States production was less than 1,250,000,000 pounds; now the production has risen to about 3,500,000,000 pounds. The first shipment of cotton-seed oil in the year ending June, 1872, was but 547,165 gallons, and few would have anticipated that it would reach in 1892 the enormous export of nearly 14,000,000 gallons, worth nearly $14,000,000. The various forms of cotton seed all yield good oils capable of being refined for dietetic use. The oil possesses excellent lubricating qualities, and is useful for soap-making and for lamps. The quantity of oil produced, even in England, is large, the imports of cotton seed exceeding in some years 400,000 tons. In the States the production of seed exceeds 3,000,000 to 4,000,000 tons, of which half is available for oil; 100 lbs. of seed will yield 2 gallons of oil. There are four qualities of oil made. The crude oil varies from a dirty yellow to a reddish color; on standing, it deposits a slimy sediment. The second quality has a pale orange color, and is obtained by refining the crude oil with a solution of caustic soda. The yellow oil resulting from this process is further purified by being heated and allowed to settle again, or by filtration, and is called 'yellow summer oil.' 'Winter yellow oil' is made from the above material by chilling it until it partially crystallizes, and separating the stearin (about 25 per cent.) in presses, similar to those used for lard. This is then treated with Fuller's earth in a tank, which holds back the coloring matter, and the oil which issues from the filter press is almost white. In 1896 there were probably 1,250,000 tons of cotton seed crushed in the United States. From this seed there were obtained 1,000,000 barrels of oil. It is estimated that 300,000 barrels were used in Chicago for making oil lard; and that St. Louis, Kansas City, and Omaha took 200,000 for the same purpose. About 250,000 barrels went to Holland for making margarine, and large quantities to Southern Europe for mixing with olive oil. Cotton-seed oil seems to be useful for table purposes, and it is desirable that its use in the pure state, rather than as a mixture, should be encouraged. It ought, however, to be sold on its merits, and with the addition of some qualifying term, which will indicate its origin. This oil has entirely replaced olive in America, and in London and Paris restaurants.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

†32393. How is Vulcanization Accomplished? (Ind Rub Wld–June 10.) 900 w.

†32395. The Mitchell Patents Not Infringed Upon.—Suit of Chemical Rubber Co. v. the Raymond Rubber Co. (Ind Rub Wld–June 10.) 1500 w.

We supply copies of these articles. See introductory.

†32396. Interlocking Rubber Tiling on the "St. Louis." Ill. (Ind Rub Wld–June 10.) 500 w.

*32413. The Teak Trade of Siam. From report of Mr. Black (*Arch*–May 31.) 3500 w.

*32427. The Life-History of the Crustacea in Early Palæozoic Times. Henry Woodward (*Nature*–May 30.) 5600 w.

†32457. Some Notes on Molecular and Atomic Refraction. W. F. Edwards (Am Chem Jour–July.) 4800 w.

†32458. A New Apparatus for Determining Molecular Weights by the Boiling-Point Method. I. H. B. Hite. II. W. R. Orndorff and F. K. Cameron (Am Chem Jour–July.) 4800 w.

†32492. The New Element of the Atmosphere. Considered by Lord Rayleigh (New Sci Rev–Jan.) 1200 w.

†32497. The Elements. William Crookes (New Sci Rev–April.) 2500 w.

†32499. The Ether and Its Functions. George Frazer Fitzgerald (New Sci Rev–April.) 4800 w.

†32502. The Operation of the Vibratory Circuit. John W. Keely (New Sci Rev–April.) 2500 w.

32517. Industrial Progress in the Arts. A. V. Newton (Inv Age–June.) 4600 w.

*32565. Scientific and Technical Societies. Editorial (Engng–June 7.) 2500 w.

†32648. Geological Sketch of Florida. E. T Cox (Tr Am Inst Min Eng–June.) 3000 w.

32663. Impressions of Japan. E. C. Potter (Ir Age–June 20.) 2000 w.

*32743. Argon. Lord Rayleigh (*Nature*–June 13.) 7000 w.

32785.—$1.50. The Topographic Map of the United States. Ill. Herbert M. Wilson (Am Soc Civ Eng–May.) 5200 w.

†32787. Picturing the Planets. Ill. James E. Keeler (Cent Mag–July.) 5300 w.

32815. Cold on Tap (Mas St Fit–June.) 450 w.

†32829. The Bowels of the Earth. Alfred C. Lane (Pop Sci M–July.) 4200 w.

32839. Lord Kelvin. Ill. Arthur Warren. Extracts from Pall Mall Gazette (Elec Wld–June 29.) 2000 w.

†32867. On the Correlation of New York Moraines with Raised Beaches of Lake Erie, Frank Leverett (Am Jour of Sci–July.) 8000 w.

†32868. On Some Compounds Containing Lead and Extra Iodine. H. L. Wells (Am Jour of Sci–July.) 2000 w.

†32869. The Estimation of the Halogens in Mixed Silver Salts. F. A. Gooch and Charlotte Fairbanks (Am Jour of Sci–July.) 1800 w.

†32870. On the Pitch Lake of Trinidad. S. F. Peckham (Am Jour of Sci–July.) 7000 w.

†32871. On Some Reptilian Remains from Triassic of Northern California. Ill. John C. Merriam (Am Jour of Sci–July.) 700 w.

†32872. A Further Contribution to our Knowledge of the Laurentian. Ill. Frank D. Adams (Am Jour of Sci–July.) 5000 w.

*32892. The Metric System of Weights and Measures. G. H. Baines (*Col Guard*–June 21.) 1200 w.

*32914. A Standard of Sound. Hiram S. Maxim (*Engng*–June 14.) 1000 w.

32974. The Descent of Man. Edward Drinker Cope, in N. Y. Herald. (Sci Am Sup–July 6.) 2000 w.

*32991. Engineers of To-day and Yesterday. Frank William Webb. Ill. (*Eng Rev*–June 20.) 1200 w.

*33013. The "Distress of Nations." James M. Beck (Am Mag of Civ–July.) 9000 w.

*33014. The Citizen a Sovereign. Wilmot H. Goodale (Am Mag of Civ–July.) 3000 w.

*33015. Ought We to Annex Cuba? A Symposium (Am Mag of Civ–July.) 5000 w.

*33018. The Public Schools and Good Citizenship. Charles R. Skinner (Am Mag of Civ–July.) 2400 w.

†33019. Remarks on the Genus Nanno, Clarke. Ill. Alpheus Hyatt (Am Geol–July.) 3800 w.

†33020. Steps of Progressive Research in the Geology of the Lake Superior Region Prior to the Late Wisconsin Survey. N. H. Winchel (Am Geol–July.) 2800 w.

†33021. Actinophorous Clarki, Newberry. Ill. E. W. Claypole (Am Geol–July.) 1900 w.

†33022. Camptonites and Other Intrusives of Lake Memphremagog. Vernon F. Marsters (Am Geol–July.) 4300 w.

†33023. The Kame-Moraine at Rochester, N. Y. Ill. H. L. Fairchild (Am Geol–July.) 4000 w.

*33035. Technical Research. Editorial. (*Engng*–June 28.) 2800 w.

*33063. Periodic Functions Developed in Fourier Series—The Graphical Method. John Perry (*Elect'n*–June 28.) 700 w.

†33076. India-Rubber as an Agent of Civilization. Gustav Heinsohn (Ind Rub Wld–July 10.) 1400 w.

†33077. Carriage Wheel Tires in England. Ill. Joseph T. Wicks (Ind Rub Wld–July 10.) 700 w.

†33078. The Question of Tire Guarantees. Hawthorne Hill (Ind Rub Wld–July 10.) 2200 w.

Serials.

24462. Graphic Statics. Ill. W. W. F. Pullen (*Prac Eng*–Began Aug. 10, 1894—21 parts to date—30 cts. each).

27198. Refrigerating and Ice-Making. (Sta Eng–Began Nov., 1894—7 parts to date—15 cts. each).

29531. A History of the Last Quarter-Century in the United States. Ill. E. Benjamin Andrews (Scrib Mag–Began March—5 parts to date—30 cts. each)

31336. British Fuses for Modern Guns. Ill. (*Eng*–Began April 19—Ended June 7—2 parts—30 cts. each).

32657. Colorado Marble. George C. Underhill (Stone–Began June—1 part to date—30 cts).

COMMENT & CRITICISM

Anchor Ice.

IN your April number Mr. Frank S Mason contributes a theory as to anchor ice which involves the formation of ice crystals having a temperature of 16° F. near the upper surface of water at 32° F. The physical qualities of ice forbid the acceptance of this assumption without the clearest experimental proof that it is a fact.

Ice is a conductor of heat. It is true that, compared with many other substances, its conducting power is small, but that it is a conductor must be admitted. Otherwise it would be impossible to freeze solid cakes of ice in metallic moulds, as is done every day in artificial ice-making. In this operation the water does not freeze from the top, as in rivers, ponds, and lakes, but from the bottoms and sides; and the central core of water can be finally congealed only by the passage of heat through the solid ice previously formed. This is strictly a process of conduction. The law of heat conduction is that the rapidity with which heat passes through a conducting body is inversely as the thickness. That is to say, the thinner the conducting body is, the more rapidly will heat motion penetrate the mass. The crystals or spicules of ice which mark the initial point of the freezing of water are extremely thin, and it could be proved mathematically that, if such spicules at 16° F. were cast into a large body of water at 32° F., they would assume the latter temperature before they could have time to sink even a few inches, to say nothing of a few feet.

The sinking of such spicules would be extremely slow, even were it possible to maintain their temperature while sinking, the difference between their specific gravity and that of water not being sufficient to compel rapid sinking. Again, it is well known that small particles of even much heavier bodies than water sink slowly and with difficulty, owing to the large surface resistance in proportion to their total weight. I have frequently seen particles of gold crystals float on the surface of water. The precipitation of heavy solids in a finely-divided state from aqueous solutions often requires hours, and even days, in laboratory work.

For these reasons I cannot accept Mr. Mason's theory of the formation of anchor ice. I think the phenomenon is wholly due to regelation of ice at 32° F., in water agitated sufficiently to intermingle the ice crystals with it at varying depths of submergence.

LEICESTER ALLEN.

Brooklyn, July, 1894.

Hydraulic Engineering.

IN connection with your recent remarks on Indexes (January issue), it may be of interest to you that I have here a card index of hydraulic engineering, which now contains over 8000 cards and includes both book and periodical literature;—also a topical index of the subject, without references, in dictionary form, giving the subjects or headings in alphabetic order, with cross-references, and an analysis of each important heading, as *canals, rivers, water supply, &c.* The latter now covers about thirty pages of type written foolscap, and is growing.

I am willing and anxious to make this index of general use, and would be glad to coöperate with anyone in any desirable way. It would give me pleasure also to show the index at any time, or to describe my work in this connection in detail.

GEORGE D. COLTON.

Collinsville, Conn., June 20.

Parks, Parkways, etc.

THE paper on "Parks, Parkways, and Pleasure Grounds," in your May number, is the most extraordinary production in many respects that I ever read, and I have read such things all my life.

How any man can in one breath recommend that each member of a governing body shall be grounded in the "truth" of landscape, and that "it is not necessary or even advisable" that a resident superintendent shall have a thorough horticultural training, is inexplicable.

I have not time to enter upon a full criticism, but I will say that there are numbers of men in America, even in Massachusetts, who know plagiaristic styles when they see them, and who also know that barberries, buckthorn, and privet are not necessarily foreign, and, when they are, are naturalized completely.

It is a most extraordinary assumption on the part of your correspondent that no city other than New York can afford to pay competent men.

I feel absolutely certain there are a dozen men to be had in the country, any one of whom would serve permanently for from $2000 to $5000 per year.

I am not certain, however, that any one of them could be induced to serve such political hucksters and busybodies as constitute "governing bodies," on any terms.

JAMES MACPHERSON.

Trenton, N. J., July 6.

Wood Stave Pipe.

In the June number of your magazine we notice an article by A. Lakes on wooden stave water pipe, in which he claims that it is the invention of a Mr. Allen. We write to state that the idea is as old as the hills. While we admit that the west is a great country, we of the east still have some "ideas" left.

Nearly 30 years ago we made wood stave water pipe, having had a three-sided planer built expressly to plane the staves. Our pipes run from 30 in. to 60 in. in diameter, and from 50 ft. to 400 ft. in length; and, when used to convey water from our dams to the water-wheels at the powder mill, the hoop we use is far superior to that employed by Mr. Allen. We had a cast-iron block made and cored for rod-ends the rod having two nuts, which make it much better than a rod with only on nut. We have seventeen water-wheels, and are using wood pipe for each wheel. Allen's pipes are miles long, and ours are short, but the "idea" is the same.

H. A. WELDY & CO.

Tamaqua, Pa., June [illegible], 1895.

Low Prices for Iron Ores.

In the excellent paper on "The Advance in Modern Iron Smelting," published in the June number of THE ENGINEERING MAGAZINE, I was surprised to note that Mr. John Birkinbine failed to take into consideration the low cost of iron ore, when discussing the wonderful output and cheapness of American pig iron. There is no one factor, within my knowledge, that has so greatly tended to reduce costs as the prices for ore. Within 5 years they have fallen from $5.50@$5.75 to $2.75@$3.00 per ton for bessemer ore at Cleveland, O., which means a difference of nearly $5.00 per ton of pig. What other single item has been reduced an equal amount?

S. S. F.

Chicago, June 10, 1895.

An Error.

On p. 397 of your issue for May, Nemo, in "Comment and Criticism," makes an error I am sure you would wish to correct, —*viz.*, the paper that stole Dr. Emery's article is *The Indian Engineer*, NOT *Indian Engineering*.

I am not interested in either of the papers; so may add that I happen to know that the proprietors of *The Indian Engineer* are merely advertising agents, who got the paper by a shabby trick from the former owner, and who conduct it entirely by the aid of scissors. No engineers in India read the thing, and I suppose it runs on the money of too confiding English advertisers.

R. T.

Lyncroft, England, June 20, 1895.

[We regret that the mistake made by our correspondent "Nemo" in the letter referred to should have been undiscovered before publication. We offer apologies to *Indian Engineering* for this oversight. —THE EDITOR.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

The New Process Raw Hide Co., Syracuse, New York, U. S. A.=Catalogue, 94 pp., 3½″×6″. [Describes and illustrates the new process, raw hide, noiseless solid spur, bevel and friction gears, washers, etc., etc , manufactured by this company. Also a line of raw-hide bound mallets and chisel handles. Cover, robin's-egg blue and black.]

The Arthur Company Machine Works, New York, U. S. A.=Illustrated price-list, 32 pp., 5¾″×8¾″. [Cover, dark blue and black.]

Speidel & Roeper, Reading, Pa., U. S. A.=Catalogue, 28 pp., 4½″×7½″. [Describes and illustrates the "Patent Economic" safety hoists manufactured by this company, of capacity 500-30,000 lbs, includes portable hoists, overhead tramways, travelling cranes, portable derricks, stationary hoists, and cellar hoists.]

The Torrey Roller-Bushing Works, Bath, Me., U. S. A.=Catalogue and price list of bushing and sheaves, hoist wheels, composition sheaves, washers, binnacle bells, fog bells, windlasses, side lights, zinc letters, water marks, manrope stanchions, well wheels, and brass finished deck-plates manufactured by this Co.]

Fred J. Meyer, 22 Beekman St., N. Y., U. S. A.=Catalogue 7 pp., 6″×9″. [Paper boxes.]

Keuffel & Esser Co., New York, U. S. A.=Pamphlet, 27 pp., 9″×6″. [Describing the "Pilot" File System for binding, indexing, and arranging letters and other documents. The system comprises a variety of appliances, all of which are illustrated and described.]

The Norwalk Iron Works Co ,Norwalk,Conn., U. S. A.=Pamphlet, 32 pp., 7″×9″, entitled "A Few Facts Concerning Machines for Pumping Natural Gas." [Contains a large amount of practical and useful information upon this subject. One of the tables has seemed of sufficient importance to be re-printed in our department of mechanical engineering, which see.]

The Avondale Marble Co., Avondale, Pa., U. S. A.=Pamphlet, 12 pp., 4½″×7″. [Describing the building, bridge, and dimension stone from the Echo quarry of the Avondale Marble Co. Contains analyses, both mineralogical and chemical, made by eminent scientists, absorption tests performed in various technical laboratories, tables of crushing strength, crushing tests performed by authoritative experimenters, etc. These reports and tests emphasize the wide difference that may exist in stones as well as in other constructive materials.]

The New York Belting and Packing Co., New York, U. S. A.=Catalogue and price-list, 96 pp., 5½″×8½″. [Describes and illustrates one of the largest lines of rubber goods carried by any house in the world. Also a line of Vulcanite Emery wheel goods, hose pipes, sprinklers, etc.]

The Jeffrey Mfg. Co., Columbus, O., U. S. A.=(1) Catalogue, 144 pp., 5″×7½″. [Describes and illustrates a line of chain belting, steel cable conveyors, labor-saving appliances, elevators, conveyors, carriers, power-transmission machinery, mill, factory and mine supplies and mining machinery, manufactured by this company.] (2) Catalogue, 48 pp., 10¾″×7¾″. [Illustrating and describing the Jeffrey patented coal-mining machine-drills, electric mine locomotives, elevating and conveying machinery and complete coal-mine equipments. This catalogue is beautifully printed and illustrated, and contains a department of useful and general information relating to various practical details of mine engineering, including general information relating to electric dynamos, motors, and wire, and concluding with a table of dimensions of resistance of pure copper wire.]

The American Boiler Co , Chicago, Ill., U. S. A.=(1) Pamphlet, 12 pp., 9″×6″. [Describes and illustrates the "Advance" hot-water heater for warming residences and other buildings by hot-water circulation, with tables of capacities and dimensions.] (2) Pamphlet, 20 pp., 9″×6″. [Describes and illustrates the "Tropic" hot-water heater for warming residences and other buildings, manufactured by this company, with list of buildings in which the heater is used, and tables of capacities and dimensions.] (3) Leaflet, 4 pp , 9″×6″. [Describing and illustrating the "Modern" safety sectional steam boilers for hard or soft coal, and for heating all kinds of buildings.]

The Link-Belt Engineering Co , Nicetown, Philadelphia, Pa., U. S. A.=An album of blue prints, 32 sheets, 10″×8″. [This is an exceedingly interesting collection, illustrating coal handling in locomotive coaling stations (of which a large variety of illustrations are given), and, also, industrial, electric-light, and street-railway-car plants erected by this company. Descriptive text for each of the illustrations is printed on the margin of the sheet. The collection represents the most modern advances in coal handling and coal conveying, and will repay close examination by those who wish to be well informed upon this subject.]

The Deming Co., Salem, Ohio, U. S. A.=Catalogue, 232 pp., 7″×10″, bound in stiff cloth covers. [This is a very important catalogue, the alphabetical classified index of which occupies nearly three full pages, including classes of goods only. It describes and illustrates a long line of hydraulic goods, including iron and brass pumps for hand, wind-mill, and power use, hydraulic rams, artesian well brass cylinders, pump fixtures, well tools and supplies. Besides describing and illustrating this line of goods, the book contains a great deal of practical information, some of it in tabulated form, relating to water discharged per minute at different elevations, figures and formulas which will assist in ready calculation of hydraulic problems, tables of sizes of pipe fittings, etc.]

The Adams Boiler Co., Cleveland, O., U. S. A.=Pamphlet, 11 pp. [Discusses the advantages of heating feed water for boilers, and also describes and illustrates the Adams feed-water heater and purifier, with testimonials from those who have used this feed-water heater.]

THE

ENGINEERING MAGAZINE

VOL. IX. SEPTEMBER, 1895. No. 6.

THE BUSINESS SITUATION IN REVIEW.

By Newton Sharp.

TO obtain the best possible insight into present conditions of trade and finance, and to obtain the most accurate estimate of the future, it is necessary to examine all of the many factors contributing to their development. A review of the past and an outlook into the future disclose many points that are good, some that are doubtful, and a few that are distinctly unfavorable. It is cheering, however, to be able to declare that at the present time the factors working for good outnumber by far those which may be viewed with concern, and the trend of the doubtful ones is also favorable. It must be remembered, however, that, before we can attain a high level of prosperity, there are many matters to be adjusted ; others which must pass from a state of doubt to one of certainty ; and still others which must be corrected by human energy and ability. The period of depression through which the country has passed is too fresh in men's memory to enable them to proceed with decision and confidence. But credit is being restored, and confidence is growing everywhere. That is the chief and most important change in the situation. It only remains that their growth should be unchecked for the improvement begun this year to lead to a degree of prosperity to which the country has been a stranger for more than a decade.

It is necessary to revert to the execution of the bond contract between the secretary of the treasury and the Morgan-Belmont syndicate in order to attain a clear view of the situation. It is evident that the remarkable change which followed the making of that contract was due, primarily, to the restoration of confidence in the stability of the

Copyright, 1895, by the Engineering Magazine Company.

government finances, and it is to be noted that it was not until the adjournment of congress that the stock market, which is always first to reflect an approaching change in conditions, began the wonderful advance which apparently has as yet by no means culminated. That the improvement in securities was due almost entirely to restored confidence and credit is clearly shown by the fact that at that time there was almost nothing else to justify an advance in the market. Business was at its lowest depth of depression, and showed scarcely a sign of recovery : railroad earnings showed constant and heavy decreases, with no apparent chance of improvement. It was idle to talk about the crops at that time, not only on account of the season, but because the low prices obtaining for all of the country's staple products tended to induce farmers to plant as little as possible. Since that time innumerable developments have taken place, which not only justify the course of the stock market, but which, if continued along their present lines, would also justify a greater augmentation of values. An estimate of the probable course of stock prices, to be correct, must also be an estimate of those matters which determine the prosperity of the country. The revival of credit and confidence has found a wonderful reflection, not only in the value of securities, but in a revival of trade ; and it is not too much to say that the rise in the prices of staple products and of metals may to a great extent be referred to the same cause.

Those matters, then, about which as definite information as possible must be obtained are as follows : first, the crops ; then the general trade situation as it is, and its probable development and expansion. Our foreign trade relations as reflected in the rates of exchange must be duly considered ; the re-organization and the management of our great semi-public corporations must be taken into account ; and, last of all, the political outlook needs to be carefully weighed. Definite knowledge of the crops should be had certainly within the next 15 days. So much depends on an at least fair harvest that it would perhaps be wise to postpone a consideration of the present and future state of trade and finance until exact information is had concerning it ; but at this time the cheerful crop outlook is one of the distinctly favorable features of the situation, and it ought to be remembered that, even admitting a somewhat smaller yield of wheat and cotton than last year, the higher prices the country will obtain for both of these staples will more than offset the loss to the country at large through the decreased yields.

The Government crop report published on the 10th of August showed conditions such as had been generally expected, except that the percentage for cotton, 77.9, was considerably below speculative calculations. The showing for corn and wheat was about what had been expected. Estimates based on those figures indicate the enormous yield of about 2,390,000,000 bu. of corn. The wheat yield, including both spring and winter crops, was estimated from the showing at 396,000,000 bu., of which the spring crop will furnish about 168,000,000 bu. The low percentage for cotton as indicated in the report sets forth a yield of about 7,500,000 bales.

Ever since the formation of the bond syndicate sterling exchange has ruled at rates which, during the past few years, have been coincident with heavy shipments of gold to Europe. This tendency has been interrupted only once, and then for a brief time. Our position as a debtor country is familiar to every thinker. It would be difficult to estimate the debt of this country to Europe, representing foreign capital invested here in railroads, innumerable corporations of other kinds, municipal securities, business, and the open money market. The foreign exchanges at a given time represent the difference between a normally favorable trade balance on the one hand, and, on the other, the settlement of the interest, dividends, and profits on our foreign debt, and such other obligations as tourists' expenses and freight charges. Broadly speaking, then, an export or import movement of gold reflects the inward or outward flow of foreign capital. Prior to the formation of the bond contract, there was a constant withdrawal of foreign capital and a steady liquidation of securities owned by foreigners which threatened an almost immediate suspension of gold payments by the United States government. Since that time, while this process, in bulk, has been no longer continued, the situation has been but little relieved by foreign capital, and Europe has shown little other favorable interest in our securities than that undertaken on the bull side of the stock market. As it seems probable that the country will have a smaller available surplus of wheat and cotton for export than usual, it would appear that no relief can come to the exchange market other than from a revival of European confidence in our securities.

Several banking and commercial houses not included in the syndicate or obligated by its provisions have, since the middle of July, been shippers of gold either in settlement of their foreign obligations or to make the profit possible through selling bills at the prevailing rates and shipping the actual gold against their sales. It is understood that the syndicate members will not themselves ship gold during the life of the bond contract. By assumption the contract runs until October 1. The backward condition of the grain and cotton crops results in a diminished supply of the usual features of exchange, and, beyond the purchases from time to time of gilt-edged bonds, the exchange market has not been relieved by European takings of our securities. At this writing the shipments of gold on this movement aggregate about $14,000,000. Of this amount the treasury has lost all except about $500,000. Out of their surplus holdings collected at the formation of the syndicate and since, the syndicate managers have reimbursed the treasury about 50 per cent. of the loss through the gold shipments. The question of a further strengthening of the gold reserve through another issue of bonds is not an imminent one. At the same time, as long as the government revenues run behind the expenditures, as at present, and as long as the government remains in the position of a quasi bank without the powers of a bank, the foreign exchanges will be a disturbing factor.

This distrust seems to be referable to two matters: First, the political outlook, as viewed from a foreign standpoint; and, second, the reckless mismanagement of our corporations, which has resulted in the periodic, partial, or complete collapses of companies like the Atchison, the Erie, the Northern Pacific, the Reading, the Union Pacific, and the Norfolk & Western, in all of which companies European capital is largely involved. The bankruptcies of these companies, deplorable in themselves, have served to direct foreign attention to the manner in which our great corporations are mismanaged,—a mild term for the policy which allows some minor subordinate officials to precipitate and conduct wars of rates, simply that they may be able to return to the board of directors superficially favorable traffic returns. In any other line of business a man who conducted his business at a constant loss would be called a fool, and would be taken charge of by his friends; yet, to put the matter in a homely way, that is just what a large number of the railroad companies of the country are doing at the present time, and the same policy appears to be in favor among another group of corporations of tremendous influence,—namely, the anthracite coal producing and carrying railroads. Foreign advices and newspapers show that public opinion abroad is thoroughly roused on this subject, and it is idle to expect a renewal of European interest in our securities until an end is put to this discreditable business.

The political outlook, however, is assuming a more favorable turn. The action of the new congress on the currency and silver questions will have a powerful influence on foreign sentiment,—an influence so powerful, in fact, that it may enable the country to take strides ahead which will make such measure of improvement as it has enjoyed seem trifling. Hard work is being done, both by the advocates of sound currency and the heretics. The battle seems to be on the side of the just.

In taking up the general business situation and its outlook, we find that, as in the financial situation also, there are signs of various and varying kinds, but that the drift is towards betterment. At the present time the only unfavorable features are those which might be explained away on account of the season of the year, or which are the result of apprehensions concerning either legislative possibilities or questions affecting the currency. The tariff revision of 1893 taught this generation a lesson of which many were entirely ignorant,—that, regardless of the equities of the changes made, a derangement of business is almost certain to accompany the process of effecting those changes. Since the next congress will not be in sympathy with the executive of the nation, we shall probably enjoy a relief from further meddling with the tariff, and all that business requires is to be let alone. The political complexion of congress makes it quite certain that no extreme changes will be made in our currency system. For these reasons business and finance seem assured of a comparatively long period of freedom from legislative interference, and discussion concerning them may proceed without taking undue account of their influence.

By far the most important and significant feature in the general situation is furnished by the wonderful revival in the iron and steel trade. The advance, which began in pig iron, has now spread to all the forms in which iron and steel are manufactured for use, and the general advances are sustained by an activity which is only interrupted as is the rising tide, each wave, on receding, being followed by another that breaks further up the beach. The most careful calculations can detect no material set-back to the growth of these industries for more than a year, and that this fact is appreciated by the largest manufacturers is shown by their willingness to place large orders, the fulfilment of which extends far into 1896. On the whole, the amount of business sustains a remarkable volume considering the heavy production, both of those mills which continued in operation during the business depression and of the many that have started up since. The orders for steel rails, for instance, for the first half of the year, aggregate 713,000 tons, against 502,000 tons for the same period of last year,—an increase of over 40 per cent. The same ratio of gain is seen in many other industries. As was so ably pointed out by Mr. Edward Atkinson in his article entitled "The Signs of the Times" in the August number of this magazine, few people yet comprehend that the iron and steel industry of this country is undergoing a wonderful transition, and one, it is safe to say, that involves the ultimate transfer of the paramount control of the production of iron and steel from Europe to this country. Mr. Atkinson estimated that during the next 5 years there will probably be at least 30,000 miles of railroad constructed in this country. When it is considered that, in addition to this, the present mileage, which amounts to 180,000, stands largely in need of repair and new equipment, it is difficult to see anything else than a most prolonged period of activity ahead, both for iron and steel, and, indeed, for all of the forms in which iron is used. The measure of advance already attained, both in the crude and manufactured articles, has raised fears in some quarters that prices will attain a figure at which our mills will be brought into competition with those of England, and for that reason some critics deprecate any further advance from the present level of prices. We are not able to sympathize with this view. Unless the sober estimates prepared by Mr. Atkinson and collated from other sources are at fault, there is business enough in sight for everybody, and, as the present revival cannot be expected to continue indefinitely, it will be just as well if some part of the tremendous prospective demand should be filled from abroad. Otherwise, in so far as the enormous demand may be somewhat spasmodic, it will only lead to the construction in this country of unnecessary plants, which later might find themselves unemployed when the next ebb tide of industry sets in. Observers all recognize that there are tides in trade as there are in the ocean ; the important fact to be recognized is that the tide has now turned, and is making for the flood level.

The figures presented by the bank clearances for July are distinctly encouraging, and not less so because of the fact that perhaps some branches of trade contributed rather disproportionately to the total, since there is no more favorable feature of the general situation than that the spirit of improvement has spread from one line into another, lifting them all out of stagnation and leaving them on a better and healthier basis. The average increase in clearances for July was 29.8 per cent., whereas the average for the whole year was only 16.1 per cent. Outside of New York the totals for the same periods were 21.7 per cent. and 10.3 per cent. It is to be remembered also that the month of July was not one of active speculation either in the stock or the cotton markets of New York.

As showing the steady decline in business activity during the years 1893–94, and the strong recovery of 1895, the following detailed record of clearing-house exchanges is full of significance :

MAY.

	1893.	1894.	1895.
Boston	432,500,000	352,600,000	417,145,000
New York	3,055,500,000	2,093,100,000	2,833,846,000
Philadelphia	328,150,000	256,500,000	297,800,000
Baltimore	63,700,000	59,500,000	58,100,000
New Orleans	41,800,000	32,600,000	36,000,000
St. Louis	109,150,000	98,000,000	113,600,000
Chicago	461,100,000	378,500,000	430,100,000
Cleveland	25,600,000	19,400,000	23,800,000
Pittsburg	66,800,000	57,400,000	64.700,000
Omaha	29,500,000	21,800,000	14,400,000
Kansas City	49,600,000	40,000,000	45,100,000
San Francisco	69,700,000	60,100,000	54,600,000

JUNE.

	1893.	1894.	1895.
Boston	367,900,000	327,100,000	387,900,000
New York	2,625,900,000	1,898,600,000	2,480,900,000
Philadelphia	305,100,000	242,600,000	305,800,000
Baltimore	63,900,000	56,500,000	59,800,000
New Orleans	33,700,000	28,000,000	31,800,000
St. Louis	95,300,000	91,300,000	101,700,000
Chicago	377,500,000	357,900,000	385,000,000
Cleveland	23,900,000	20,900,000	23,900,000
Pittsburg	57,900,000	55,400,000	62,900,000
Omaha	26,400,000	22,900,000	13,600,000
Kansas City	40,400,000	37,600,000	42,300,000
San Francisco	57,400,000	51,200,000	59,300,000

JULY.

	1893.	1894.	1895.
Boston	374,200,000	332,000,000	448,400,000
New York	2,393,400,000	1,843,400,000	2,527,300,000
Philadelphia	280,700,000	250,200,000	305,300,000
Baltimore	60,850,000	60,600,000	64,000,000
New Orleans	27,500,000	27,400,000	29,200,000
St. Louis	82,600,000	87,500,000	103,400,000
Chicago	350,700,000	323,100,000	403,400,000
Cleveland	22,900,000	20,700,000	28,300,000
Pittsburg	51,200,000	57,400,000	69,800,000
Omaha	22,300,000	19,100,000	14,300,000
Kansas City	27,400,000	36,000,000	41,300,000
San Francisco	49,900,000	45,600,000	58,900,000

The inevitable conclusion remains that, allowing for the period of crop uncertainty, there is an improvement which has come to stay. It is an aphorism that business creates other business, just as a contraction in any one line is reflected through all others. Taking the least enthusiastic view of the outlook, only the wilfully perverse will take any but a conservatively hopeful view of the country's future.

The object of this article has been to take a conservative view of the situation as it is and of the future as it will probably develop. We repeat that the corner-stone of the change in the average condition of the country during this year has been the restoration of credit. It is clear that unwise legislation or a turn in the political situation, which, fortunately, there is now little reason to fear, may undo all that has been already accomplished. The era is distinctly one of regeneration ; the building and re-building noticeable in all lines of trade and finance are simply the result of revived credit and confidence. They are in the sharpest contrast to the failures, corporate bankruptcies, and general disintegration of the past few years. We believe that, however tiresome the reiteration of the idea may be, the future depends on the common sense of the country,—its common sense commercially, financially, and politically. These matters are not to be considered apart, and it behooves every individual to use his personal influence with his neighbor in the line of proper thought.

THE EMANCIPATION OF LABOR BY MACHINERY.

By A. E. Outerbridge, Jr.

WHEN Adam Smith published in 1776 "The Wealth of Nations," a book which is still regarded as a sort of gospel of political economy, the education, environment, and general condition of the laboring classes was radically different from those of the present day. Very many of the most important trades and professions were not then in existence, and the educational influence of machinery had scarcely more than touched the intellect of the artisan with its quickening impulse. Yet we find that modern writers continue to apply the creed of Adam Smith to social conditions of to-day, which are as far removed from those existing in England a century ago as the present civilization of the United States is in advance of that of China.

A student of industrial sociology who approaches the study of the mutual relations of employer and employee, having the advantage of some practical experience in the workshop and of daily contact with workingmen engaged in mechanical or other occupations requiring skill, is impressed with the fact that the best-known authors—those whose tenets are the most universally accepted—have been, as a rule, college professors and scholastics whose knowledge and intellectual acumen, though profound, are altogether theoretical. Such writers are prone to formulate theories which too often have but scant foundation in fact, and reveal the lack of personal experience from the operative's standpoint; they are apt to accept dogmas of their predecessors without question, and thus they continue to promulgate obsolete fallacies.

The doctrines of social economics are not to be accepted on faith, nor are they founded on faith; and they are necessarily subject to continual revision in order to adapt them to changing conditions.

In Adam Smith's day the proportion of operatives who were intellectually in touch with current events, beyond the mere routine of "days' work" and narrow sphere of daily existence, was infinitesimally small. At the present time the general diffusion of knowledge, through free education in the public schools, the wonderful digest of the world's events in the daily papers, and the general dissemination of elementary science by cheap magazines, has percolated down to almost the lowest stratum of the wage-earning class. The affairs of the nations are intelligently discussed at dinner-time, in the lodge, and wherever workingmen congregate.*

In great political crises the wage-earners in this country form a "court of last appeal," in which the intelligent jury may, as a rule, be depended upon to decide important questions in a thoroughly comprehensive manner

Those who were privileged to listen to a farewell address on "Social Conditions in England," delivered in Philadelphia last spring by Professor W. Hudson Shaw, of Balliol College, Oxford, who has been lecturing during the past two winters in this country in the University Extension Course, obtained much valuable, though painful, information regarding a condition of labor-unrest in England, which presents strong points of contrast to the intellectual, social, moral, and physical condition of the working-people of this country.

In the course of this address the speaker exhibited a book called "Merrie England," written by a journalist named Robert Blatchford, regarding which the following remarkable statement was made, the quotation being given from memory ; "Before I left England 600,000 copies of this book were sold, and before I return I believe that a million copies will have been sold to working-people. Each copy has been carefully studied by not less than five persons, and we thus estimate that five million working-people have now read and accepted the doctrines of Robert Blatchford. Yet the ruling classes of England to-day are so far from being in touch with the state of things as they exist among the masses that they know nothing of this movement, which is destined to create vast changes in the complexion of social and political affairs in England in the near future. Lord Rosebery, until a recent period, had not even heard of this book."

Since Prof. Shaw's return to England, Lord Rosebery's administration has been overthrown, and the statement has been noticed in print that more than a million copies of "Merrie England" have been sold, the present price of the book being one penny!

Curiosity induced me to purchase a copy of this book, then unknown in America, though it has recently found its way across the water and is reprinted in cheap form for popular distribution. It is remarkable for its vigorous style, being often dramatic, but it is calculated to do much harm to the workingman, though, fortunately, the social condition of the wage-earning class in this country is not such as to nourish such seeds of discontent.

---

* "The educational influence upon the operative of daily contact with machinery is, in my judgment, a potent one, enlarging his mental horizon, giving him more accurate perceptions of the true relations of parts and fitness of things, and elevating him intellectually above the average plane of the former handicraftsman."—"The Educational Influence of Machinery." ENGINEERING MAGAZINE, May, 1895.

It consists of a series of letters addressed to a supposititious "John Smith," a weaver of Oldham, who is taken as the representative of the working-class in England. The utter hopelessness and misery, depicted in these letters, of the workingman's life in that country cannot fail, whether true or false, to arouse the slumbering fires of discontent in the minds of those to whom the letters are addressed. "The factory system," "the private ownership of land," "the capitalistic press," "the parliament of landlords," and other "wrongs" too numerous to mention are inveighed against in powerful language.

Then, by way of contrast, a socialistic Utopia is pictured to the weaver's bewildered brain, in which beautiful fields, woods, gardens, cattle, streams, birds, and flowers abound, and the writer says: "You know that all these things are well worth having, and that none of them exist side by side with the factory system. . . . I despise the factory system, and denounce it as a hideous, futile, and false thing. . . . . Rent, interest, private ownership, machinery, and competition are all instruments in the hands of the capitalist, and with those instruments he compels the worker to give up nearly all his earnings in return for permission to work."

Here we have the whole economic teaching of the book embodied in a few sentences: the capitalists—that is to say, the employers—are robbers; the factory and the machinery in it are mere instruments of robbery; and the only means of escape for the wage-earners is to vote for the socialistic ideal, wherein the State would be the sole proprietor and employer. The effects of such teaching are seen plainly in the pronounced socialistic organization and tendency of the London county council; in the dogged opposition of the English trades unions to the introduction of improved machinery and improved methods of production; and in Mr. Herbert Spencer's recent cabled declaration that he regarded "the advent of socialism as the greatest calamity that has ever befallen the human race." In a word, as the result of false teaching, the industrial population of England seems to be setting its face squarely against progress.

It is now admitted that the introduction of machinery has proved beneficial to the wage-earning class, and the fear that the substitution of machinery for human toil would prove disastrous to wage-workers has been disproved. Yet, in spite of this, no longer ago than 1877 the University of Cambridge, England, awarded the "Cobden prize" (£60) to J. S. Nicholson, B. A., for an essay on "The Effects of Machinery on Wages," in which the author italicizes the phrase, "Machinery of itself does not tend to develop the mind," and again says: "It is clear that the use of machines, though apparently labor-saving, often leads to an increase in the quantity of labor; negatively by not developing the mind, positively by doing harm to the body.'' Further, he quotes John Stuart Mill to the effect that ''labor-saving inventions have not lightened the toil of any human being; they have only enabled a greater number to live the same life of drudgery and imprisonment.'' These references are given, not for the purpose of argument, but to show that scholarly writers often fail, through lack of practical knowledge, to perceive facts as they really exist.

Costly experiments have been made in the mining regions of Pennsylvania, and in some large industrial works in this country, during the past score of years, in the introduction of foreign ''pauper labor,'' but I believe that the universal experience has been, at least in manufacturing industries, that ignorance is the most expensive element that can be introduced in the modern complex manufacturing system, and intelligence is again receiving due recognition. Several large steel and iron makers, bridge constructors, and others have testified that the result of this pauper labor experiment has proved that the comparatively high-priced, intelligent labor of English-speaking operatives is, in the end, far more economical than that of Huns, Poles, and other semi-civilized people who emigrated to this country in vast hordes some years ago for the purpose of supplanting native labor at low wages. The old adage that ''main strength and stupidity'' comprise the working capital of the average workingman is no longer applicable, for the operative is not regarded as a mere machine, but as an intelligent being, whose business it is to control machines.

Not only did the cost of errors in work and injury to machinery which were traced to the ignorance and stupidity of the pauper labor element outbalance the difference in wages paid formerly to educated workmen, but the labor strikes, lawlessness, and crime of all kinds, beginning with the ''Molly Maguire'' reign of terror in the coal regions, were due largely to this foreign importation. The intervening periods of depression in manufacturing have resulted in a general exodus of this disturbing element, and it is not likely that employers will again attempt to evade the contract-labor laws by subterfuges such as were believed to have been formerly adopted. The recent voluntary action of employers in raising wages is encouraging, not only as an evidence of returning prosperity, but as indicating a growing appreciation on their part of the economy of fair wages and intelligent service as compared with poor wages and ignorant labor.

The emancipation of labor by machinery may now be conveniently considered under the following heads:

1. Amelioration of exhausting toil.
2. Intellectual and social elevation of wage-earners.

3. The influence of machinery on the future relations of capital and labor.

The examples which might be given to illustrate the first proposition are so numerous and self-evident that the reader may readily supply a long list from personal observation. One of the interesting proofs of the lightening of toil by the aid of machinery is found in the constantly enlarging sphere of labor being opened to self supporting women, and the prediction is here made that within the next quarter of a century the ranks of the mechanic will be largely augmented by women. Already many of the newer industries, such as the manufacture of incandescent electric lamps, are practically in the hands of women. In every field where women have entered they have proved themselves apt scholars and expert workers, so that the prejudice which formerly excluded them from many trades is fast dying out. No more convincing proof that "main strength and stupidity" are giving way to manual dexterity and mental activity as the working capital of the wage-earner could be adduced than this.*

The once familiar outcry that the sewing machine would deprive the poor seamstress of her means of subsistence, and that it was therefore "a criminal invention," still lingers as a memory in the minds of many who have lived to see far different practical results therefrom.

Statistics show that the number of women to whom the sewing machine gives occupation to-day is vastly greater than the number who formerly gained a precarious livelihood with the needle, or who could obtain similar work now under old conditions.

Contrast the "work-a-day" clothes and simply-made "Sunday-go-to-meetin'" garments of the people of a century ago with the wonderful variety and complexity of finery comprising the holiday attire, and, indeed, the every-day wearing apparel, of those of a similar class to-day. If it is true, as stated, that one sewing machine operated by one woman will do the work of ten hand-sewers, it is no less true that the modern woman possesses ten times as many garments as her sister of a former age, and each garment displays ten times as much machine-sewed work upon it.

If you examine the quaint hand-made costumes of dames of high degree of the revolutionary period, which are carefully preserved in glass cases in old "Independence Hall" in Philadelphia, you will see that this statement is literally true. We have thus shown an enormous actual increase of sewing work *per capita*, rendered possible by the machine.

If we should extend this inquiry farther, we would perceive a still wider opening of the doors of labor to women through the sewing machine; in textile decoration and in almost every department of household art and luxury we can trace its influence.

---

*According to the last census, the number of women, engaged in various trades and occupations in the United States increased during the decade 1880–1890 over 250 per cent.

The sewing woman has reaped the benefit of this expansion of opportunity for remunerative employment and improvement of methods of work; the plaintive "Song of the Shirt" has not such general application as of old; the pathos of self-sacrificing labor, often continued into the small hours of the night, has been in large measure relieved by organization of such labor under proper regulations; so that (excepting the criminal "sweat-shop system," conducted by foreigners in cellars and obscure tenements) the sewing machine has conferred vast benefits upon the very class whom it was supposed it would most disastrously affect, while the number of men employed in the manufacture of sewing machines constitutes a vast army.

But the sewing machine is a mere suggestion. The mind is fairly staggered in contemplation of the wealth of opportunity for wage-earners that has been created by the steam engine,—especially in the form of the steamship and locomotive, which have literally opened new worlds to the old world's poor. And what is true of the steam engine is true only in lesser degree of the telegraph, the telephone, the electric motor, the turbine, and the whole range of modern agricultural machinery.

The modern bicycle—a theoretically perfect invention, and, in some respects, an almost perfect mechanism—has already produced beneficial effects upon the physical development of the wage-earning class sufficiently marked to attract general notice, and its future influence is incalculable. It is destined, in my judgment, to emancipate woman from many of the conventional shackles which have bound her for ages, and from some physical disabilities which have hitherto limited her sphere of occupation. This is only one of the many striking instances in which invention is helping to benefit the masses.

I am convinced that modern mechanical inventions have in all cases proved to be distinctively beneficial to the wage-earner. He is through their aid better housed, better fed, better clothed, better educated, has more numerous and better amusements, and is thus approaching more nearly the condition of life of the employer; indeed, the wage earner to-day enjoys many advantages of civilization which were unknown to the employer of a generation gone by.

The majority of employers in this country are men who have risen from the ranks, and many of our most important inventions have been made by wage-earners, who have the best opportunity, through experience in their daily work, to learn the necessities of the age.

In Europe the mechanic belongs to the "second class," and in

England even the professional man, unless gifted with exceptional ability and renown, is on a social plane inferior to that of the titled idler. In America wage-earners possess distinct advantages over those of Europe in that "class distinction" is not tolerated, and the few attempts to arbitrarily separate individuals into classes, irrespective of personal qualifications, in imitation of foreign aristocratic ideas, have only succeeded in bringing ridicule upon the authors. But in Europe the lines are so sharply drawn that it is far more difficult for merit to obtain the recognition which is so freely accorded in America and to which this country so largely owes its phenomenal success.

With respect to the second proposition,—*viz.*, the intellectual and social elevation of wage-earners through the influence of machinery,—equally numerous and forcible illustrations might be given, but one example will perhaps suffice to emphasize this claim, not only in regard to labor in general, but to self-supporting women in particular.

The modern invention of the typewriter proved a valuable boon to women, opening up immediately new fields of labor of elevating character; but it is doing more than this. The daily experience in affairs which the operators are gaining through their work is fitting them to fill much more important positions in life, and future writers on social economics will be compelled to recognize this new element; but the subject at this point leads off at a tangent from our main topic.

A careful personal investigation into the home life of the well-to-do wage-earning class in Philadelphia (an ideal city in this respect) has revealed remarkable progress in the education and intellectual development of the members composing such families; the "general average" has been raised many points in the life of a single generation; there are comparatively few workingmen's homes in Philadelphia, which I have visited, where you fail to find educational books relating to the occupations of the bread-winners; and the American Encyclopædia is not an *edition de luxe*, kept for show, but a tool of frequent use. The cheapening of such literature through the aid of improved printing-presses is largely responsible for its wide distribution in such homes.

The student who desires to arrive at an approximately correct judgment of the extent of this intellectual and social progress of the wage-earner, which I have endeavored to describe from my own observation, should select a period of time for comparison sufficiently remote from the present to afford striking contrasts; to do this he need not retrace his steps beyond the beginning of the present century.

Great Britain was, at that time, the home of manufacturing industries; cities like Birmingham and Manchester were already congested centers of mill-operative population; the era of mechanical invention had just opened, and its beneficial effects were not yet apparent.

Operatives in factories were herded together like animals, and housed in a worse manner. They were regarded by employers, not as intelligent human beings, having individual mental qualities and endowments, but as so many mechanical units, each one a duplicate of the other. Philanthropists and sociological writers regarded the operatives collectively only, and in the speeches of the great orators in parliament the same impersonal classification is apparent. Even in historical and lighter literature the mental endowment of the mill operative is shown to have been of the most limited kind. Such study will throw into bold relief the contrast between the past and present condition of the wage-earner, which I have only outlined.

With respect to the third and final proposition,—*viz.*, the influence that machinery is destined to exert upon the future relations of capital and labor,—a few thoughts only must suffice to show the nature of my belief.

The labor conflicts which have occurred in the past in Great Britain were, if the evidence is reliable, spontaneous uprisings of masses of downtrodden operatives, driven to despair through long continued oppression. Many battles of nations which are recorded in history were less sanguinary and less prolonged than some of the dreadful industrial disturbances to which I refer.

The strikes which have occurred in recent years in this country have not been spontaneous uprisings, but have been caused and directed by a few ambitious leaders, who have assumed the dangerous position of dictators ; they have blindly led hosts of trusting and often innocent followers, usually to ignominious and deserved defeat. These conflicts have been waged, as a rule, against railway and other corporations, and not against individual employers, and have been mainly supported by an ignorant foreign pauper labor element ; they represent a phase of development which could, in all probability, have been avoided, had a really great and wise leader opportunely appeared upon the scene.

We have observed the rise and fall of several misguided leaders, and of impracticable labor unions.

The "walking delegate" has disappeared, and the honest workingman has now learned from sad experience to beware of these drones, who thrive without toil by preying upon their fellows.

Never before has labor received the grand opportunity which is now presented to it, in the returning tide of prosperity in this country, to show the refining influence of "trial by fire" through which it has passed, and I am sufficiently optimistic to believe that the coming years will show that the great gulf which separates capital and labor is gradually contracting in area ; that, as education permeates the wage-earning class, the employee will perceive more and more clearly that a community of interest exists between capital and labor which he had not before realized, and will discover that many of the barriers of which he now complains were in reality erected by himself, and will then no longer be required or maintained.

Machinery, which was formerly regarded as the robber of the wage-earner, is destined, in my judgment, to become—indeed, has already become—the missionary for his enlightenment; and, when its work is fully accomplished, the conflicts which have marked this transition stage, often with a trail of blood, will become a memory of a past era of industrial semi-barbarism. I do not mean to imply that I believe the millennium is at hand, or that labor strikes will cease in a day, or in a generation; but I do believe that, just as every new invention in scientific mechanism of warfare is a step toward the ultimate abolishment of barbarous methods of deciding international complications by war, so the general diffusion of education among wage-earners through the aid of machinery and its products is a step toward the settlement by peaceful and intelligent processes of the complex questions which will arise in the future regarding the mutual relations of capital and labor.

NATURAL SCIENCE TRAINING FOR ENGINEERS.

By Prof. N. S. Shaler.

IN the reorganization of the Lawrence Scientific School of Harvard College it has been necessary to consider, once again, the important question as to the share of natural science which should be incorporated in the several four-year courses leading to the bachelor's degree in the departments of civil, electrical, mechanical, and mining engineering. In determining this matter attention has been paid to the previous experience of the school, and, so far as possible, the advice of instructors and of practical engineers has been given due weight. In effecting this reconstruction in the system of the school, the conditions were such as permitted an almost absolute freedom in the choice of subjects in natural science which should be taught. As the Lawrence school is a constituent part of the college, being under the same faculty of arts and sciences, all the extensive establishments for instruction in physics, chemistry, geology, geography, meteorology, etc., could be called on to furnish such teaching as appeared to be necessary in the project for the instruction of engineers. The results of the inquiry have to a great extent been embodied in the schemes of instruction; but it seems worth while to note the points which appear to have been established in the consideration of the problems which have been dealt with.

In the first place, it is evident that all engineers, be their particular division of the profession what it may, are necessarily too much concerned with the properties of matter. It therefore seems necessary to regard a sound general instruction in physics as an essential part of every training which is to fit men for this walk of life. The teaching should be so arranged as to afford much practice in the various kinds of measurements, and this not only because of the practical utility of such work, but also because the educative value of such exercises is exactly what is required to affirm those qualities which need to be developed in the novice. Experience indicates that, when a student in the fitting schools has had a schooling in elementary experimental physics, one course on the basis of nine hours' work each week for the college year is ordinarily sufficient to give the required training. Along with this course in physics should go a similar course in chemistry: the work here should be directed towards the end of giving the pupil a good general knowledge of the principles of chemistry, in the experimental way, so that he may become familiar with the processes of the more important arts. It is not desirable to carry this work very far into the field of quantitative analysis, that being work which is fitted for the needs of the professional chemist. On the side of metallurgy there should be a good theoretical training, with enough in the way of experiment to show the needs of the processes of casting as well as the qualities of the construction metals and their alloys.

In addition to the training in chemistry and physics it is well that engineers in general should know something of geology. The training in this science may well be limited to the general principles of the subject with a considerable exercise in the laboratory work bearing on the characters of rocks microscopically considered,—a task which involves a certain amount of teaching of determinative mineralogy. This work has to be done without recourse to the principles of mineralogical science ; it has to be mainly empirical ; but, despite the imperfections of the method, much useful knowledge may be attained. In the same elementary course in geology there is a considerable opportunity to learn the processes of field observation and to practise the methods of exploring a district. The time required in this work is about the same as that demanded in the elementary physics,—say nine hours a week during term time. To this geology should be added an elementary half course in geography, which has for its purpose to acquaint the student with the methods of interpreting the history of any area and its more essential relations to the uses of man.

The total time required for the proper study of the elements of natural science as above noted is about four-fifths of the study period of the college year,—the complement of courses for such a year being reckoned at five, while the total of this list is four. It is evident that this demand is, considering the large amount of professional work which the student of engineering has to do, rather excessive. In practice the burden can be much diminished by taking certain of these courses in the summer. For more than a quarter of a century Harvard University has maintained a summer school, in which a number of the elementary and some of the advanced courses which are given in term time are repeated. As each student is required to give his time to one course, it has been found out that the six weeks' term, owing to the concentration of attention, serves to carry the pupil quite as far as he is likely to advance in an ordinary year of work, when the equation for the loss in turning from one matter to another is so great. Therefore the elementary courses in physics, geology, and geography, as well as other courses with which we are not concerned, can, by devoting a share of the preposterously long vacation to the work, be removed from the requirements of the winter session. In practice the students of the school are rapidly availing themselves of this opportunity to lighten their labors. It may indeed be said that the tendency is to push into the summer term all the work which requires field exercises, and also a certain portion of the instruction which calls for laboratory practice. Including the year of his entrance, a student has four summers at his disposal before attaining his bachelor's degree. By giving up six weeks of each of their vacations he may win all the time required for the elementary science courses which are to be expected of the engineer. There will remain in each summer another period of a month and a half, which is quite as much as is needed, or in this busy world should be expected, by ordinarily well people, for the purposes of rest and diversion. Thus, without sacrifice of any real good,—indeed, we may say with a positive gain to the order of the student's life,—a considerable general foundation in physical science can thus be attained.

When the engineer desires to fit himself for any one of the several branches of his profession by adding to the general training, which should be alike for all those who propose to enter the calling, it is necessary for him to carry his work in particular sciences to a higher plane. These special fields, as they at present appear, may be enumerated as follows,—mechanical, electrical, marine, hydraulic, topographical, and mining engineering. I shall now proceed to consider the science work that is demanded in each of these specializations which lead the student somewhat away from the general path of the occupation.

In mechanical engineering the instruction in physics needs to be carried much beyond the elements ; the student needs to become acquainted with the facts and theory of kinetic action ; he must, in a word, be made ready for the study of the steam engine, and he must also become acquainted with the generalities of hydraulics and the modes of action of fluids and gases.

In electrical engineering the need of an extended training in physics is even greater than in the mechanical division of the subject. The student needs to be well trained in the extensive and increasing difficult lore which is developing in this branch of science. To make him ready, not only to apply the knowledge which has been won, but also to explore for himself in the inventive way in this field where so much awaits discovery, it is desirable to carry him through a range of study which will put him in possession of the electrical science of to-day. In marine engineering, for the reason that the work includes a great variety of considerations which can be fitly approached only in the scientific way, the training has to be very wide: it should include not only advanced physics, but a thorough-going knowledge of hydraulics, and also a fair teaching in electrical science and its practical applications. If this specialty is held to include the work of harbor and dock construction, which might perhaps be better classed under the head of hydraulic engineering, then there should be added to the curriculum a sound training in that part of geology which relates to the origin and regimen of harbors,—the action of marine currents and waves and the conditions of a geological nature which affect the construction work that the engineer has to do about ports. In part this learning belongs, in a strict classification, to hydraulics ; but, all things considered, it may best be taught by a geologist, for the reason that the science of the earth is a kind of learning which uses the data gathered by investigators in other fields of inquiry to explain the actions which affect the sphere, taking into account the interactions of various causes and their development in time.

In hydraulic work the engineer should be prepared to consider geological problems in a more detailed way than is necessary in any of the special divisions of this science and art. In all that relates to the complicated and most important problems of irrigation the questions as to the origin and nature of the soil, the character of the materials as affecting the storage and conveying of water, etc., need to be considered from the geological standpoint. To this knowledge of geology, strictly so called, should be added a considerable training in physical geography and meteorology. It is hardly necessary to say that the instruction needs include all the abstract science which the university may afford that bears directly on hydraulic problems.

In the special work relating to topographical surveying we find a division of engineering the importance of which has been much underestimated. It is, in my opinion, likely, in the time to come, to be one of the noblest applications of science to the need and the advancement of man. Moreover, though as yet an underpaid branch of the profession, the prizes may be expected to augment as the method of approaching a number of important problems, such as those of the landscape architect, becomes more common. When people are accustomed to use high-grade maps as true pictures of the earth's surface, as they are now beginning to do, we may expect that educated topographers will rank with the other members of the profession of engineering. Those who intend to make this subject their specialty will need a careful grounding in the general principles and the practice of geological field-work. They should also be well trained in the part of physical geography which relates to the interpretation of the development of a surface under the action of atmospheric agents. A map made by a man who knows the under-structure and geographical history of the area which is depicted is a production very different from and more valuable than a like essay by a topographer who ignorantly endeavors to delineate what he happens to see.

In the department of mining engineering we find the most perplexing part of the task of a technical school. Besides the general training in engineering, which has to be wide, the student needs a very good knowledge of geology, which should be carried far in matters pertaining to the structure, succession, and attitudes of rocks. To attain this end he needs to be fairly instructed in mineralogy and petrography, and to have some acquaintance with fossils as indices of formations. A knowledge of chemistry is equally demanded, and it has to be given in such a manner as will make the man ready for the difficult questions which the miner is apt to encounter. So, too, in the field of physics there is much which should be at the command of the engineer in this department. It may, indeed, be reckoned that, besides the general engineering training, the student who expects to devote his attention to mining work needs a body of natural science which will call for at least 1½ years of the period which he is to devote to work in the technical school. This demand is so large as to make it a question whether a good deal of the work of a practical nature, such as the details of mining methods, ore-dressing, etc., should not be left out of the instruction, with the confident belief that a knowledge of such matters will be readily acquired in the apprenticeship which awaits the young graduate in mining as it does all the men who gain their knowledge in technical schools.

It is, indeed, an open question whether our science schools are not going too far in the effort to acquaint their students with the technical details of the several departments of engineering. This instruction is given with the expectation that the graduate may the sooner be able to command a responsible and remunerative place. But it is very doubtful whether the imitations of economic establishments which are devised are not, by their lack of business quality, calculated to develop erroneous methods which will go far to offset any knowledge of the crafts which they may teach. It is likely that in the end our schools will confess a limitation in their work, and win firm ground by acknowledging that their province is to give the student a thorough education, in the original sense of the word, supplying him with a large theoretical outfit, leaving the technique of his occupation to the time when he begins his work in a particular employment. If this position is taken, there is room in a four-year course, including six weeks of each of the four long vacations, for much of the work in natural science which has been noted in this paper as proper to be introduced into the curriculum of the several departments of engineering. It seems to me that this system is very desirable for the reason that the more extended basis of scientific knowledge on which the profession would then be founded would at once dignify the education and enlarge the men who receive it.

There is another consideration which leads us to believe that the share of natural science which is introduced into the training of engineers should be large: this rests upon the need of making the men of this profession the compeers in intellectual station of educated men of the other learned occupations. In order to prepare young men for a career in engineering without an excessive expenditure of time, it is necessary to educate them in a different way from that which experience has approved for the ancient standard callings. We have to abandon the classics and much else which makes for enlargement, and trust to science to win the ends of culture. While I fully believe that natural science can do an excellent part in the civilizing process, it cannot do this if the teaching be devoted to immediate ends. The work must be done in the large, truly academic way; it must take the subject for itself, and not as a mere means to a professional result.

The foregoing remarks concerning the amount of natural science to be taught in our schools rest upon the practice of giving the bachelor's degree in engineering at the end of four years. I cannot close the consideration of the subject without a brief reference to the present attitude of our schools as regards the period of study demanded of candidates in engineering. On the basis of a preliminary training which requires at least one year less than in the case of those who enter our leading colleges, we endeavor in four years to complete an education which shall fit a man to take up his life's work in one of the most difficult callings, one in which the demands that are made on the practitioner's education are continually and rapidly augmenting. We expect the lawyer or the physician to give one or two years' additional work in the preparatory school and four years in the college before he enters on his professional education; we permit the engineer to win his lower goal with from five to six years' less study. While the way to a profession through the path of the college may be held to be too long, that through the technical school is clearly too short for the needs of the work their graduates have to do. At least one year should now be added to the length of the curriculum.

With the addition of a year to the length of the term-work of our technical schools, it would be much easier to secure a fit share of natural science in the curriculum of the engineers. There would also be a decided gain in the opportunities for instruction in English, French, and German. Moreover, the distribution of the professional studies could be much better accomplished than is possible in a four-year system.

LABOR LEGISLATION IN THE UNITED STATES.

By George Kirby Holmes.

LEGISLATION relating to labor is every year becoming more and more comprehensive, and at the present time covers a great variety of conduct, more particularly that of employers; and the question is being asked whether that point has not been reached at which this legislation is beginning to be oppressive to capital.

Much of the so-called factory legislation aims to accomplish what Herbert Spencer believes should be accomplished by the workingman himself, and is therefore a foolish paternalism. If elevator-shafts and dangerous machinery are not provided with guards, and mill doors do not swing outward, it is argued that workingmen should procure the protection that they desire by arrangement with their employers, and not procure the State's mandate to take the place of what properly belongs to the domain of private agreement. But this contention of Mr. Spencer and his extreme followers is applicable to an ideal society, or at any rate to one much more nearly ideal than our own. It is opposed by the argument that the workingman is often so near starvation, and his opportunities for employment are so limited, that he is not in a position to confer with his employer upon an equal footing.

The latter argument, carried to its logical conclusion, would require the State to take the part of the workingman in his relations with his employer within the entire field of contract, and no one but a radical Socialist would go thus far. It must be admitted that all legislation of this sort, as Mr. Spencer claims, tends to weaken the workingman's spirit of self-help, and, if any of it is to be defended, the defence must take the ground that, under the present imperfect conditions, some degree of compromise is desirable,—one that shall require the employer to do some things which unquestionable fairness dictates that he should do, and leave the workingman to strive for enough to develop his individuality and to promote his coöperation with his fellow-workingmen.

No theory can define the limits of such a compromise, but that there should be some sort of compromise is a conviction which has for years been growing in public opinion, and growing so rapidly lately that there may be danger of carrying it too far in the assumed interest of the workingman.

Labor legislation in which society may be regarded as having an interest, although not always the only interest, now includes a limitation of the hours of labor, much more of women and children than of men ; the prohibition of certain employments to women and children ; and the prohibition of the employment of children under specified ages and without a certain period of instruction in schools. It includes the securing or preference of wages due from employers of various descriptions ; it authorizes instruction in the use of hand-tools in the public schools ; it forbids the importation of alien contract labor, the employment by railroad companies of persons who are color-blind, and the employment of children under specified ages in cleaning machinery in motion or near other machinery that is dangerous.

There are laws to facilitate the formation of relief societies by workingmen, to exempt from seizure under execution the tools and materials necessary for carrying on a trade or business, and to exempt from garnishment the wages of the wife and minor children of the defendant and his own wages up to a specified amount. Convict and Chinese labor are more or less limited or altogether prohibited, the manufacture of cigars in tenement-houses is forbidden, and free lectures for working people are provided for.

Such, briefly stated, is the specific character of the legislation relating to labor in which society may be regarded as having an interest outside of any considerations of abstract justice. Within the domain of justice the legislation has been varied, and has considerably reinforced the common-law rights and responsibilities of employer and employed, besides enlarging them in some important respects.

It is provided that no person may by force or threats of violence prevent another person from doing any lawful work or from carrying on any lawful industry, business, or calling. Liens attach to property upon which labor has been bestowed or for which materials have been furnished, to secure wages and prices ; no person, on account of sex, is disqualified from entering upon or pursuing any lawful business, vocation, or profession ; the obligations of employees to perform service that has been contracted for is enjoined, and in some States this is done with special reference to employees on railroad trains and steamboats to prevent their abandoning the same before a trip that has been begun has been completed.

The common law of master and servant is more or less redefined and made more certain. The earnings of married women are secured to them as against their husbands. Blacklisting is made a crime. Employment offices can not be kept open except under certain regulations, and deception by their proprietors is forbidden.

To prevent accidents from the ignorance of stationary engineers, such engineers must have successfully passed an examination ; persons under certain ages are not allowed to have charge of elevators; and railroad companies can not employ telegraph operators without a thorough examination to establish their competency. It is a crime for any organization to prevent any person from apprenticing himself to learn and practise any trade or vocation. Railroad companies can not exact from their employees any portion of their wages to maintain a hospital, reading-room, library, gymnasium, or restaurant. The common law does not recognize damages for the instantaneous death of a person, and this has been changed so that the legal representative of a railroad employee who has been killed in the performance of his duties may carry on a suit for damages; and the common-law liability of employers for injuries to employees has been considerably enlarged.

Laws make it a crime to threaten to discharge from his employment, or to reduce the wages of, any voter, or to promise to give him employment or higher wages, for the purpose of influencing his vote. No offensive, derisive, or annoying words may be addressed to any person passing along any street to, from, or about his lawful occupation, nor can any noise or exclamation be made in his presence or hearing while so passing for the purpose of preventing him from pursuing it.

A person is guilty of a crime who breaks a contract of service, having reasonable cause to believe that the probable consequence of his so doing will be danger to life, or bodily injury, or loss or injury to valuable property. Boycotting is forbidden in Illinois, Maine, and New York, but is permitted in Maryland.

An examination of the legislation coming within the definition of justice shows that it is even more against the practices of workingmen than of employers, and that, as in the case of legislation (already considered) outside of justice and pertaining to the general social welfare, most of it has the approval of public opinion and will probably remain permanent in the body of our laws.

There now remains for examination the labor legislation that relates to matters outside of justice and general social welfare, in regard to which it may be questionable whether they should be left to regulation by contract. There is hardly any limit that this class of legislation may reach, and, while some of it prescribes duties for workingmen, by far the larger portion of it places responsibilities upon employers and may be extended a little at a time, so as eventually to become burdensome to them.

Massachusetts has gone farther in this legislation than any other State, as it has in the two other classes of legislation; indeed, the labor legislation of that State exceeds in variety, perhaps, that of all other States combined, especially so if mining laws are excepted.

An employer there cannot, by contract, exempt himself from liability for injuries to an employee which he might otherwise be under ; he cannot exact from an employee, under forfeiture of wages, a notice of intention to leave his employment, without himself being subject to the same penalty for want of similar notice of discharge ; and he must provide seats for female employees in manufacturing, mercantile, and mechanical establishments, and permit such employees to use them when their duties permit.

Factories and workshops must be suitably ventilated and provided with sanitary arrangements ; there must be fire escapes and methods and means of protection from accident ; elevators must be provided with automatic safety clutches, and elevator shafts with self-closing hatches at every floor. No explosive or inflammable compound can be used in any factory in such a place or manner as to obstruct or render hazardous the egress of operatives in case of fire ; outside and inside doors must not be locked ; if steam power is used, communication between each room where machinery is placed and the engine-room must be possible by means of speaking-tubes, electric bells, or appliances that may control the motive power ; women and young persons must be allowed to eat their meals at the same time, and must not be employed for more than 6 hours without an interval of at least half an hour for a meal.

There must be no fines for imperfect weaving, unless it is due to the wilfulness, negligence, or incapacity of the weaver, and they must not exceed the damage agreed upon by contract. No building intended to be used as a factory or workshop, or for mercantile purposes, above the second story and with accommodations for ten or more employees above that story, can be built, unless its plan is sanctioned by a specified public officer, who must see that various provisions are made for escape in case of fire and for the prevention of fire.

The construction of factories, workshops, stores, and boarding and tenement houses is subject to numerous and minute regulations pertaining to fire and health, under the supervision of a public officer, whose judgment and decisions are almost autocratic. Certain freight-cars must have safety couplers, and bridge guards must be erected to protect trainmen. Wages must be paid weekly by nearly all corporations. Besides requiring all these things, the State promotes agreements between capital and labor through voluntary arbitration, and it strengthens the contracting ability of labor by incorporating labor organizations.

Massachusetts has led in this sort of legislation, and other States have adopted many of its labor laws. In addition to this, some of them forbid employers to maintain stores, or to sell merchandise to employees for a higher price than to other persons for cash, or to coerce employees to buy at any particular store or to employ any particular physician. The cause of discharge is to be given in writing to an employee upon demand.

In some States the wages of labor employed on public works is fixed by law, but under the constitution of Louisiana no law can be passed to establish the price of manual labor. In Michigan workmen must be protected from emery dust by suitable blowers and apparatus. Wages must not be paid in Missouri with any evidence of indebtedness payable otherwise than in the money of the United States or in merchandise at current cash prices. Seats must be provided for New Jersey horse-car drivers, and in that State wages cannot be paid in merchandise or in orders or due bills. Every contract that will keep, or is designed to keep, voters away from the polls in Tennessee is void.

The most elaborate coal-mine regulations are those of Pennsylvania, and they are so elaborate that there is not space for even the most condensed abstract of them. It must be sufficient to say that they include numerous requirements with respect to shafts, slopes, structures over the surface entrances, hoisting apparatus, blasts, machinery, facilities to enable miners to change their clothes and to wash and to care for the injured, ventilation, the prevention of accidents, the organization of the working force, and the manner and means of work in great detail.

In the foregoing review of labor legislation it has been impossible to mention, even briefly, numerous qualifications of the principal features of the laws, nor has it been thought necessary, in all cases, to mention the States in which the various laws prevail.

A law, intended to accomplish a single purpose, rarely confines itself to that purpose, and doubtless the labor laws have had and will have unexpected results, immediate and remote. Much of the legislation is too recent to have produced results that can be ascertained without extended investigation, and, if they were ascertained, it would be found that they are generally not measurable.

In Massachusetts the child labor laws have had the effect of almost entirely suppressing the factory labor of children within the prescribed ages. A law was enacted in 1876 prohibiting such labor under the age of 10 years in factories and workshops, and statistics show how far it has accomplished its purpose. The percentage of children employed in manufacturing in 4 census years is exhibited below, the percentage being computed upon the total number of persons of each sex and of the total of the two sexes, of the specified age periods, in the population.

	For both sexes.	For males.	For females.
1870, males below 16 and females below 15	3·17		
1875, below 15	2·45	2.78	2.13
1880, males below 16 and females below 15	3·31		
1885, below 14	0.70	0.82	0.58

In 1870, before the enactment of the child labor laws, 14,119 children (males under 16 years and females under 15 years) were employed in manufacturing in Massachusetts; in 1880 the number rose to 17,445, but fell to 8,877 in 1890, owing to the law of 1888 raising the prohibited ages from those below 10 years to those below 13 years. These children are mostly 14 and 15 years old, since, according to the State census of 1885, the children under 14, employed in manufacturing, were 3,508, and this number must have been reduced almost to nothing by the law of 1888. In 1885 there were only 24 children under 10 years of age employed in manufacturing.

Whatever the effects of labor legislation have been in Massachusetts, they have not been felt in a way to prevent the employment of a constant portion of the adult population in manufacturing.

The following percentages show the portions that the males and females employed in manufacturing are of the total male and female population, for the special age periods:

	For males.	For females.
1870, above 16 (population above 15)	37·25	
" " 15 " "		16.20
1875, " 15 " "	37·67	14·55
1880, " 16 " "	39·72	
" " 15 " "		16.05
1885, " 14 " "	38.42	15·01

Although the foregoing percentages have not a uniform basis, they are sufficient to indicate no material effect upon the employment of working people, numerically and relatively, in factories.

If labor legislation had, in fact, produced any injurious effect upon capital, no one of them would make itself manifest more quickly than the one that touched capital's pocket. The 10-hour law was passed in Massachusetts in 1874, and at that time the hours of labor in factories were 11 in the other New England States and in New York, and often 12 in Connecticut. Here was an apparent increase of about 10 per cent. in the cost of production in Massachusetts, whose competitors were nearly all in neighboring States.

To ascertain the effect of this law the legislature directed the Bureau of Statistics of Labor to investigate, with results that can hardly fail to lead to the opinion that labor legislation would need to be very drastic before it would be felt by capital to its manifest disadvantage. After this reduction in the hours of labor had continued for

7 years, mill-owners in the adjoining States were asked how they had been affected by it, and, out of 120 who made definite answers, 100 said that there had been no effect, 10 reported that the effect had been favorable to them, and 10 reported that the effect had actually been unfavorable.

Of 102 mill-owners in adjoining States, 13 said that the 10-hour law in Massachusetts had enabled them to undersell their competitors in the latter State, and 89 denied that it had done so in their cases. In the report of the investigation, the chief of the bureau, then the Hon. Carroll D. Wright, says: "It is apparent that Massachusetts, with 10 hours, produces as much per man, or per loom or per spindle, equal grades being considered, as other States with 11 or more hours; and also that wages here rule as high, if not higher than in the States where the mills run longer time."

For want of published material, no definite conclusion of fact can be made in regard to the effects of most of the labor legislation. We know, however, that capital is sensitive to whatever makes it suffer loss, or puts it in danger of loss, and to whatever hampers its operations, and that, with a large control of the daily press, it can make its cries heard, and will do so for any length of time necessary to bring relief. Capital has another way of protesting, which legislation never contemplates and that came prominently to notice in consequence of the so-called "granger legislation" relating to railroads in some of the western States. So severe was it that railroad development ceased, and the people so suffered for want of railroad facilities that they abandoned their anti-railroad policy.

The probability is that, if any labor legislation were oppressive to employers, their conduct would naturally be such as to give their employees a share of the ill effects. For instance, if the law in relation to fines for imperfect weaving is unsatisfactory to factory owners, they have only to dispense with the services of the weavers who, under the law, are not desired. Then workingmen themselves would ask for a repeal of the law. In this way employers have a very effective remedy for excesses committed against them by legislatures.

Labor legislation has become so elaborate that it may be pertinent to question whether, in such a State as Massachusetts, where it has been carried farthest, it may not be better to leave labor to look more after its own interests and the legislature less. If employers complain of too much labor legislation, they may be reminded that, if they were more approachable to their employees and were imbued more with a spirit of compromise, legislatures would be doing less, and workingmen might not have formed the habit of asking the State to do what they should strive to do themselves.

THE MODERN PROBLEM OF GRADE CROSSINGS.

By William O. Webber.

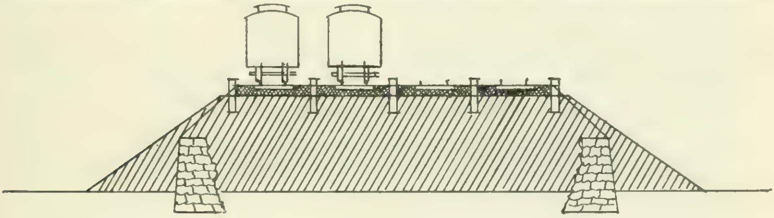
THIS problem has become one of great importance during the past 20 years, and, since the introduction of the electric street railway 8 or 10 years ago, the intersection of highways on which it is in use with steam railroads has complicated the problem and made its solution imperative. The present state of things seems to have been brought about by the indifference of the people to this question in their eagerness for railroad facilities, and by the poverty of the railroads when new. There was also an element, still surviving to a certain extent, which objected to any change in the grade of the highways, preferring to take its chances at the same level. There is also a surprising lack of information, or rather an abundance of misinformation, regarding the status of this problem. As a rule, about 28 per cent. of these crossings in the New England and Middle States are supposed to be protected. Gates and flagmen do not protect. If the gates effectually closed up the road and kept people away from the track until it was safe to cross, they would be much better; but at present only a very few pedestrians pay any attention to them. About 40 per cent. of all the crossing accidents have occurred at these "protected" crossings. There is about one grade crossing to every mile of railroad in the territory mentioned above. Grade crossings are the rule on three-fourths of the roads.

There are five types of these crossings.

First: where the highway is raised and carried over the original location of the railroad. This is the most common type, and is well illustrated by Fig. 4, which shows a highway bridge over the four tracks of the New York, New Haven & Hartford Railway at Larchmont, N. Y. This bridge is of plate iron, the floor being carried on I beams, suspended beneath the side trusses and between the tracks, so that the truss will not come over the centre of the passing train. There is a clear head-room of 18 ft. above the rails, with a raise of only 19½ ft. of the road-way above the track,—only 1½ ft. being required by this system of flooring. The cost of such a crossing over a four-track railway and with a 40-foot roadway is about $18,000.

Second: Where the highway is carried under the original location of the railway, which is probably the method that stands next in point of frequency. This is well illustrated by Fig. 5, representing a crossing near Port Chester, N. Y., on the New York, New Haven & Hartford Railroad. The bridge over the roadway is carried by half-through plate trusses on masonry piers set between the sidewalk and the roadway on the curb line. The railway tracks are then carried over the sidewalk by short I beams, which are connected with and riveted to these trusses. This is probably the cheapest form of construction for such a separation of grades, and from this point of view is to be generally recommended: as to its durability and beauty, we shall have something to say further on.

Third: Where the highway is carried under, and the railroad is also raised, as shown in Fig. 6, which represents a crossing at Holyoke, Mass., on the Connecticut River Railway, now operated by the Boston & Maine system. In this example the roadway is sunk below the sidewalk, which is left at about its original grade, and a plate truss is carried over the whole opening, but supported by iron lattice posts on the curb line and also in the centre of the roadway. The roadway has been dropped about 5 ft. and the railroad has been raised about 10 ft., making the head-room over the roadway about 13 ft. and leaving the head-room over the sidewalk about 8 ft. Other illustrations of this type of crossing will be shown further on.

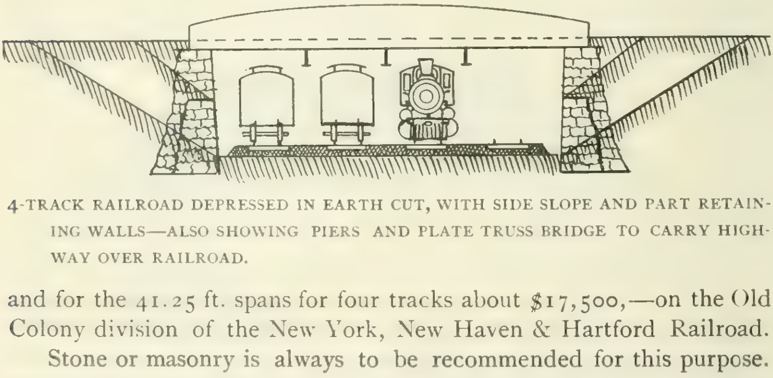


4-TRACK RAILROAD ELEVATED ON EARTH FILL WITH SIDE SLOPE AND PART RETAINING WALLS—ALSO SHOWING POSITION OF PLATE TRUSSES TO CARRY RAILROAD OVER HIGHWAY.

Fourth: Where the railroad is carried over the highway, the latter being left on its original grade. A very good illustration of a similar separation of grades of this class is shown in Fig. 7, representing a crossing on the Dedham branch of the New York, New Haven & Hartford Railroad, Providence division, at the site of the old Bussey "Tin Bridge." This is a sightly structure of Ashlar masonry, but is perhaps a little too severe in its appearance except for use in the rural districts among hills and heavy timber. Other examples of this class of crossing on a grander and more continuous scale is shown by the masonry viaduct of the Pennsylvania Railroad from West Philadelphia to the Broad street station, through Philadelphia.

Fifth: Where the railroad is carried under the highway, the latter being left at its original grade. This method is very rarely employed; Figs. 2 and 3 illustrate it.

Railroad structures over highways seem to be the coming practice, especially in populous districts. People congregate about the streams and water-courses in valleys, where a separation of grades by raising the railroad is always attended by a benefit in the general gradient of the railroad, and gives greater head-room to all traffic on the river or streams passing beneath the railroad bridges. Furthermore, by reason of the close proximity of a great number of highways to the railroad, it is less expensive to raise the railroad than to raise the streets and pay damages to adjacent property. This question of damages and costs will be referred to later. More ornate examples of railroad structures over highways are to be seen at Springfield, Mass., on the main line of the Boston & Albany Railroad, where the railroad has been carried over the main street on a beautiful arch of masonry, as shown in Fig. 8; and similar bridges are being built at Brockton, Mass.,—the cost of the 50-ft. arches for four tracks being estimated at $23,500, and for the 41.25 ft. spans for four tracks about $17,500,—on the Old Colony division of the New York, New Haven & Hartford Railroad.



4-TRACK RAILROAD DEPRESSED IN EARTH CUT, WITH SIDE SLOPE AND PART RETAINING WALLS—ALSO SHOWING PIERS AND PLATE TRUSS BRIDGE TO CARRY HIGHWAY OVER RAILROAD.

Stone or masonry is always to be recommended for this purpose. from the standpoint of economy, although the first cost is much larger The Pennsylvania Railroad Company evidently understood this when it built its viaduct into the Broad street station in Philadelphia, having found that the average life of iron bridges on its road was only about 14 years, it being very difficult to prevent them from rusting or the rivets from working loose in the plates. Iron or steel structures are also calculated only for a given maximum load, and, as the rolling-stock of all of our railroads is continually increasing in weight, the iron structures need often to be strengthened or entirely replaced; while a masonry arch, once in place, lasts forever, is stronger than any other known form, and practically increases in strength, up to the crushing-point of the stone, with the load placed upon it; from an artistic point of view, too, it is much preferable, as may be seen in Fig. 8.

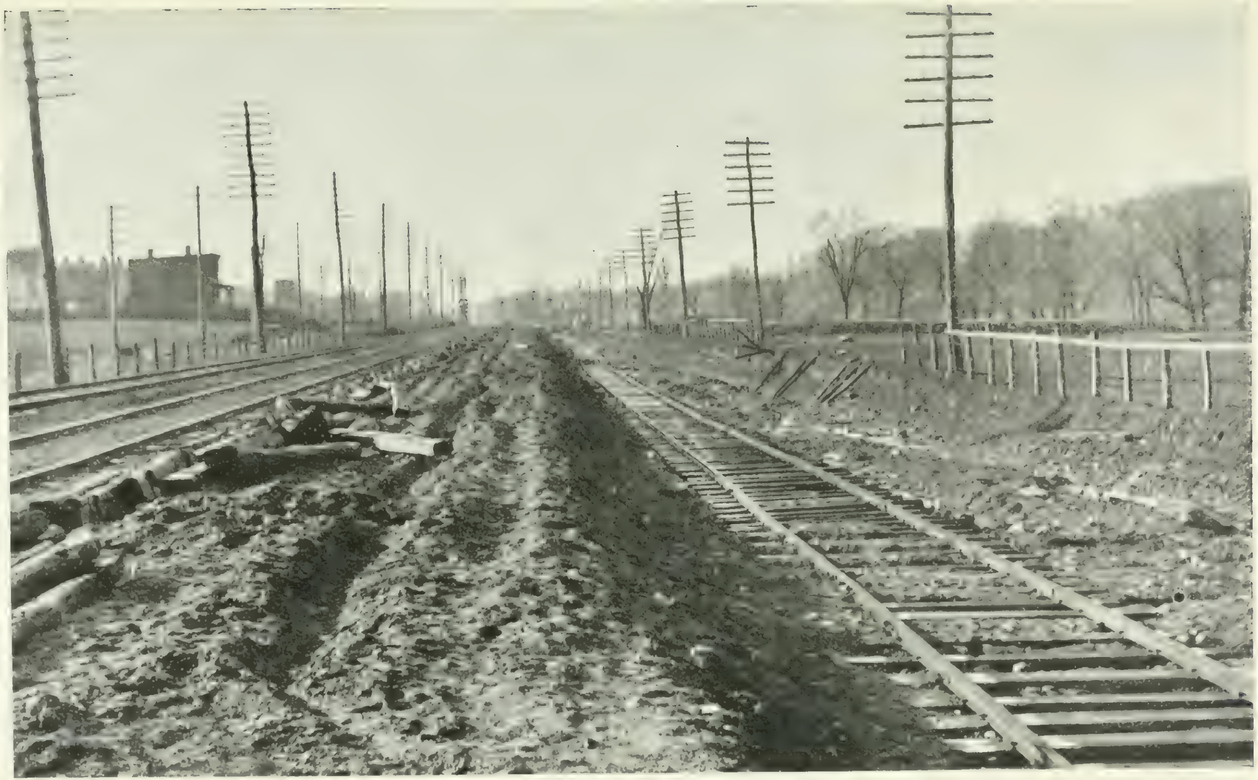


FIG. I.—BEGINNING OF CUT, FORDHAM, N. Y.

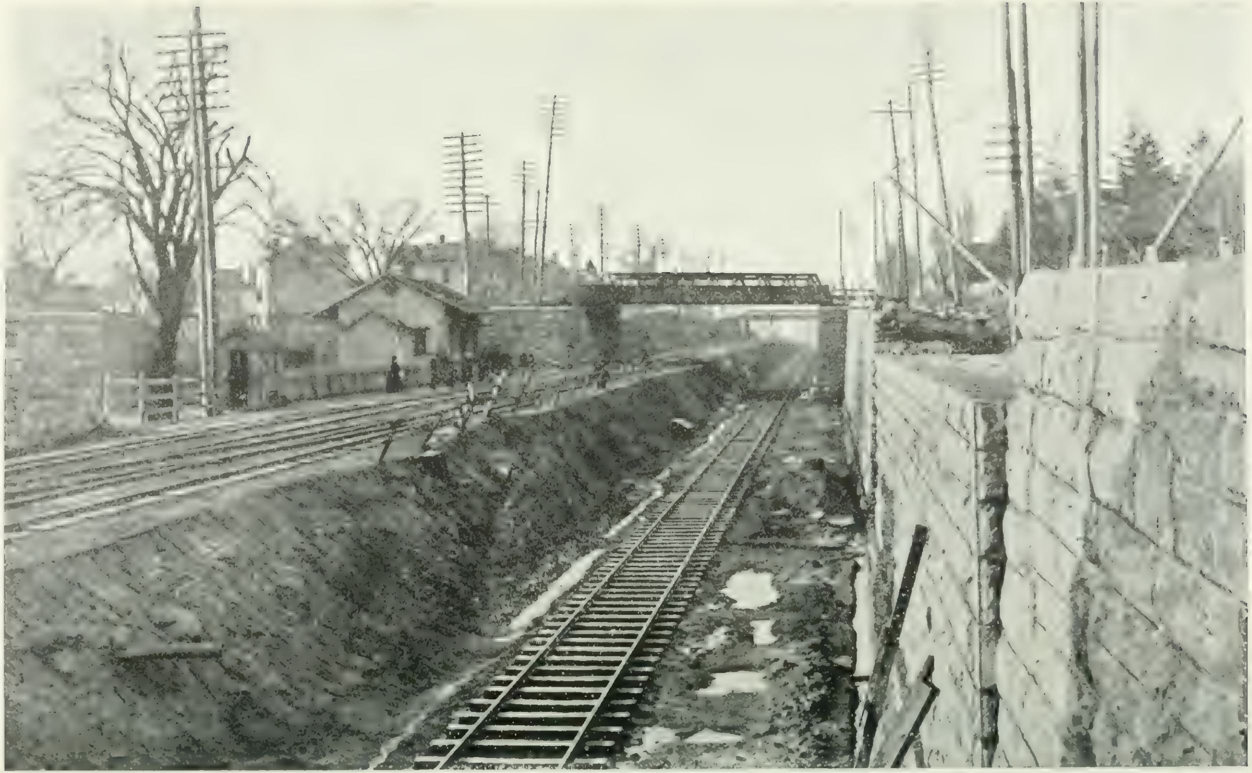


FIG. 2.—CUT NEAR MELROSE STATION, N. Y.

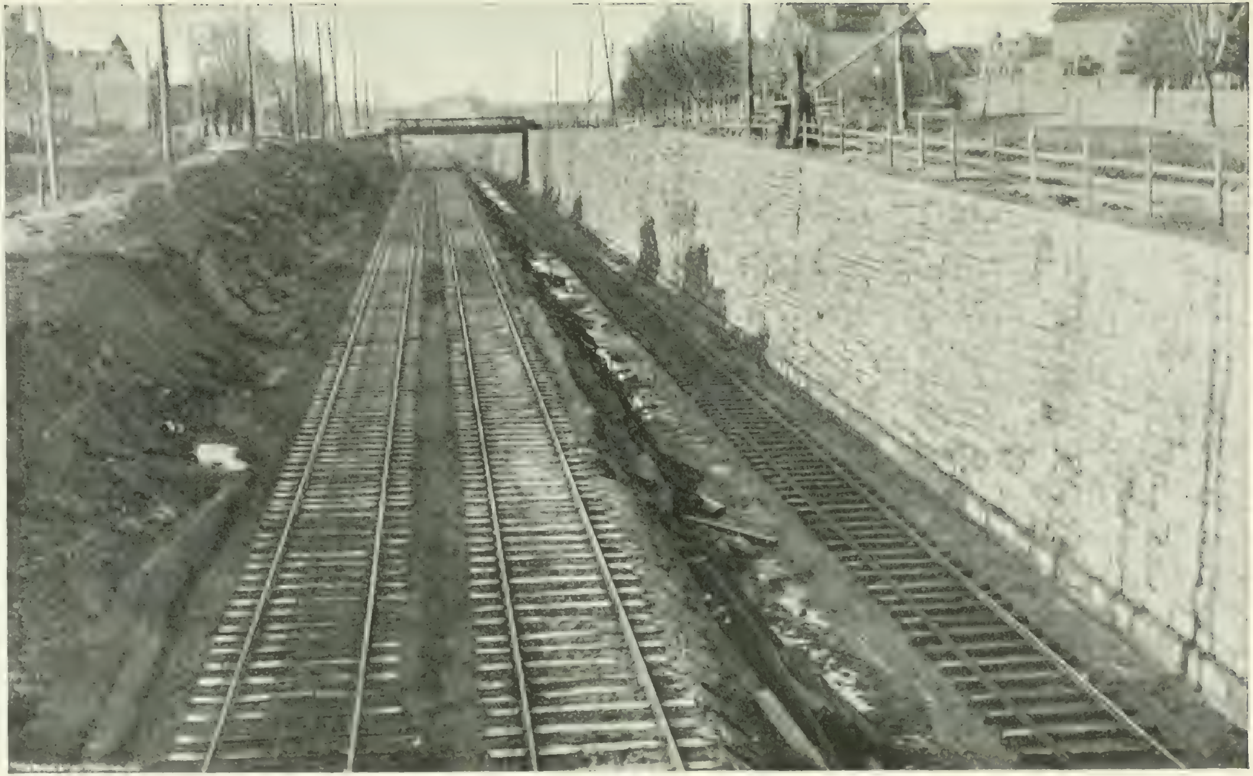


FIG. 3.—SOUTH FROM MELROSE BRIDGE.

Other things being equal, it is always less expensive and more expedient, both as regards time and obstruction to traffic, to raise the railroad over the highway. In the first place, whether built on an embankment with the natural sloping walls or with retaining walls built up part way, the elevated railroad better accommodates itself to a narrow location, as may be seen by the two accompanying sketches, both of which are for a four-track location with the tracks 15 ft. apart from centre to centre,—which is rather more than common, 12 ft. being the average. The elevated railroad has 15 ft. of head-room over the highway, the trusses carrying the railroad being 6 ft. in depth, and the depressed railroad has 18 ft. of head-room under the highway bridge, the top of the floor of which is 19½ ft. above the rails on the railroad track, both cases conforming to the law in the States where they occur. In the elevated structure, with the walls built up part way, the location occupies 80 ft. In the depressed road, with similar walls, the location would occupy 95 ft. With retaining walls built up the whole height the elevated structure would require only from 60 to 65 ft., while the depressed railroad would require 90 ft.; on earth embankment with natural slopes the elevated road would require 115 ft., and the depressed railroad in an open cut with natural slopes would require 135 ft.

It is also easier to raise a railroad track by dumping grading on either side of the track and lifting the track a foot or so at a time, tamping the material under and allowing trains to be run slowly over the track so raised, until it is thoroughly tamped and settled. In depressing tracks it is necessary to build a parallel track alongside the present location and tear up original track so as to dig under it. Of course, if a four-track railroad was to be raised and the location was one where there were many highway crossings in close proximity, it would probably be better to start by building trestles over the highways and a new grade on two of the tracks, utilizing the other two for traffic, and afterwards to shift the traffic to the two tracks thus raised, and then raise the two remaining ones. This was the way that the Illinois Central Railroad raised its track opposite Jackson Park in the southern part of Chicago. Notable examples of railroad elevation (perhaps with slight depression of the streets) shortly to be undertaken in thickly-settled communities are to be seen on the Providence division of the New York, New Haven & Hartford Railroad, from Chickering station in Boston to Forest Hills and Mt. Hope station,—a distance of about 2 9-10 miles. These changes will abolish twelve very bad grade crossings,—that at Tremont street in Boston, long known as the "Roxbury Crossing," being one of them.

The railroad will be raised as much as 16 ft. in some cases, and

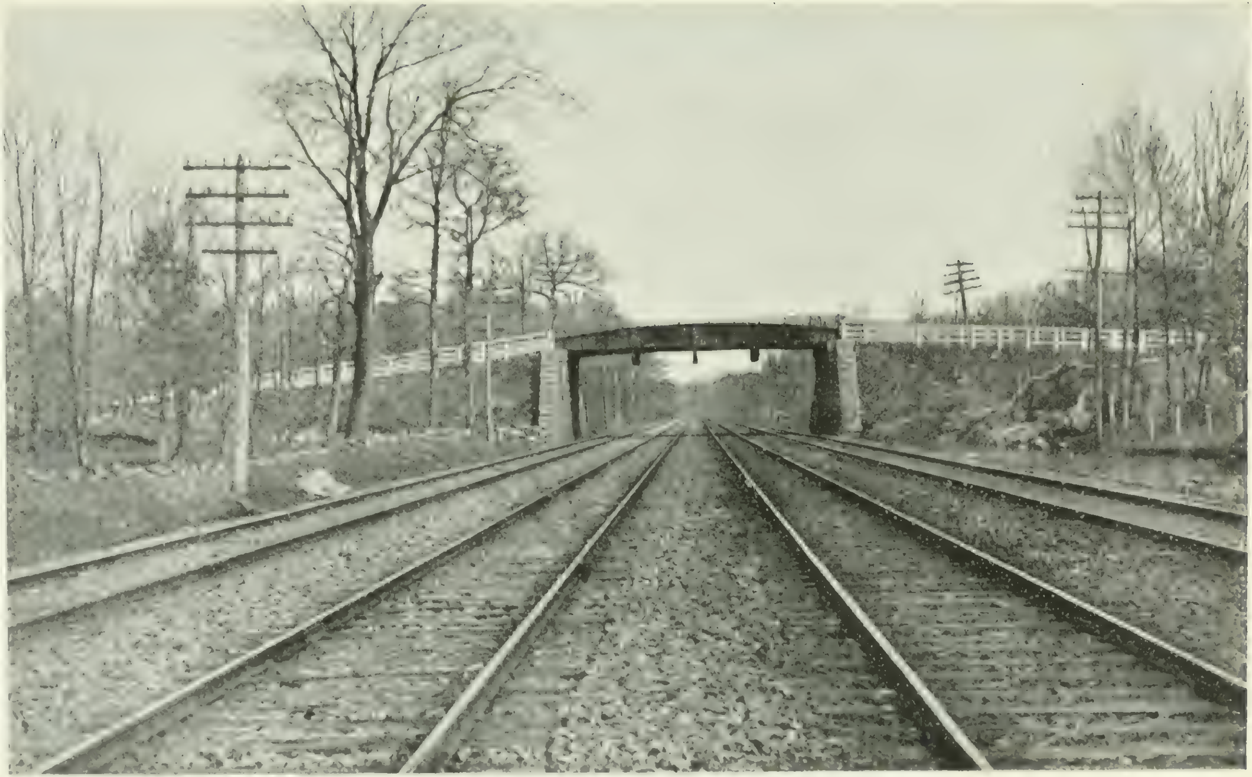


FIG. 4.—HIGHWAY BRIDGE OVER RAILROAD, LARCHMONT, N. Y.

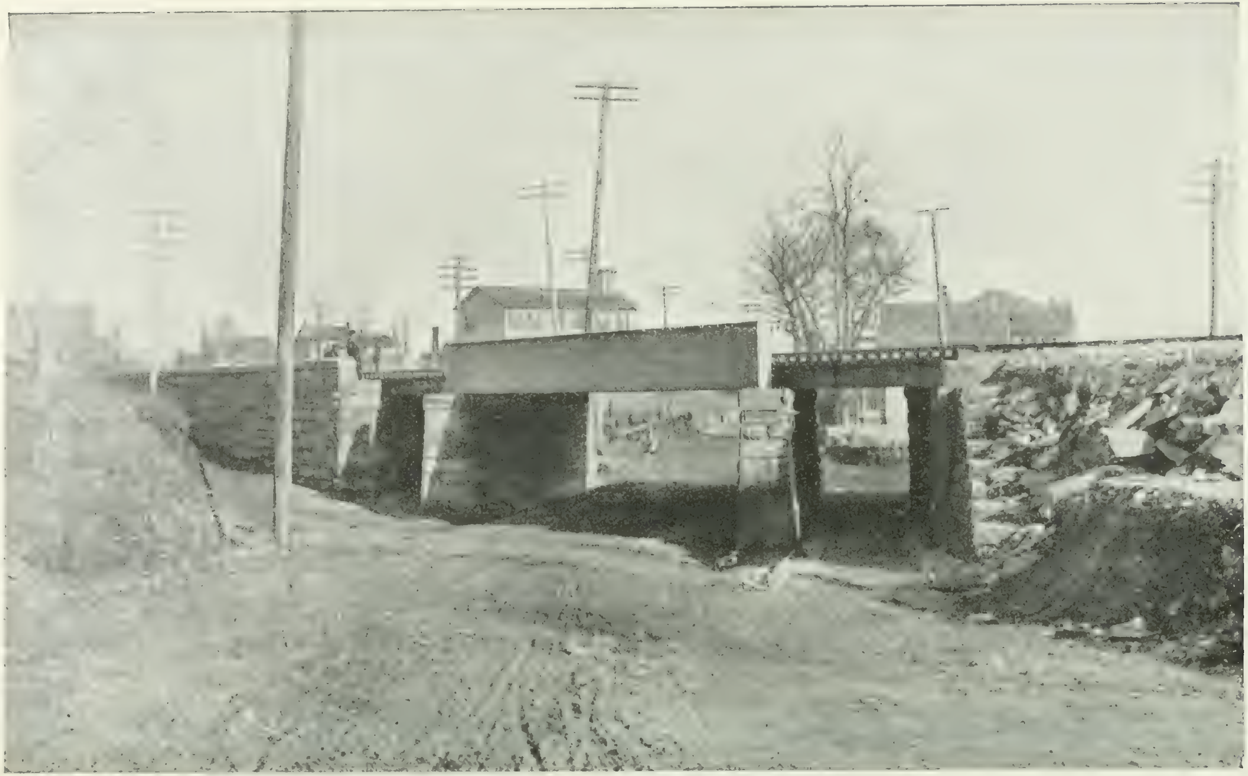


FIG. 5.—HIGHWAY, UNDER RAILROAD, PORT CHESTER, N. Y.

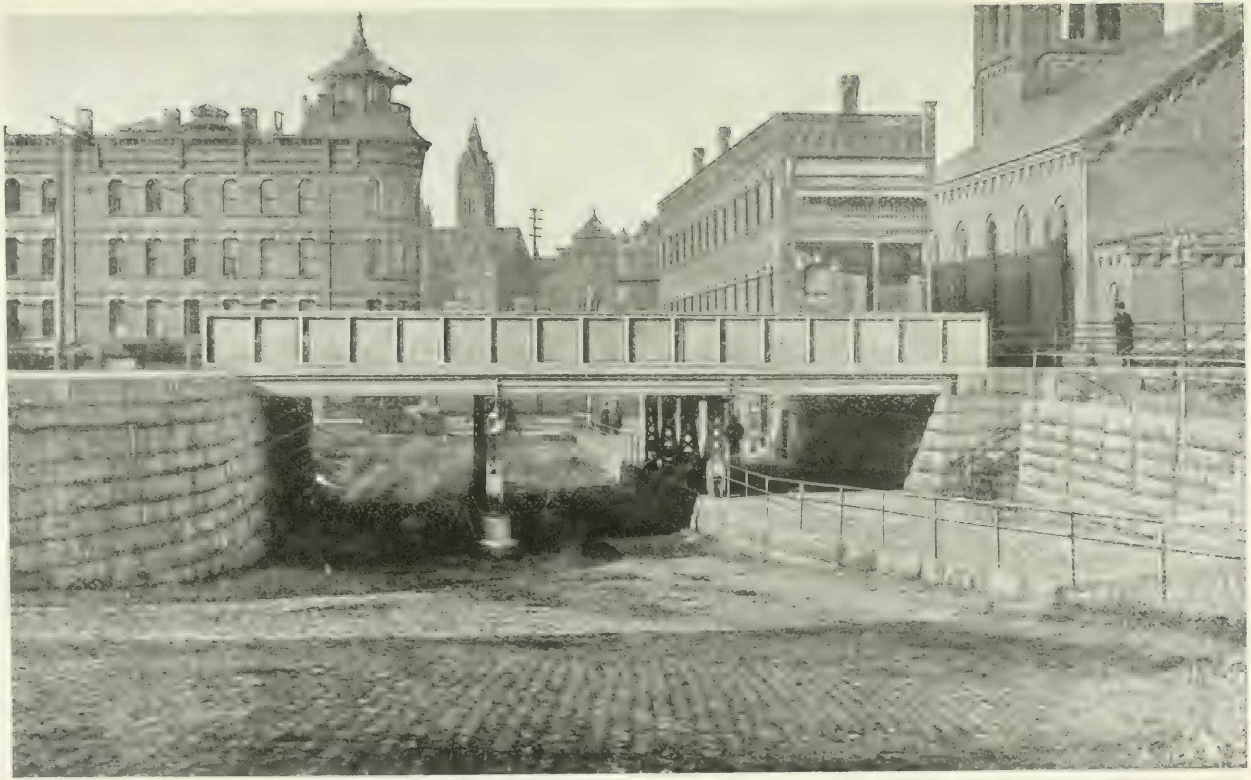


FIG. 6. — MOSHER STREET UNDER RAILROAD, HOLYOKE, MASS.

the streets depressed all the way from 1 ft. to 5½ ft. The proposed changes introduce a maximum grade of only 29 ft. per mile, while that of the old location was considerably more. All through trains on the main line going south have to go up a 42-ft. grade near Canton, and all trains going to the Dedham branch have to ascend a 49-ft. grade near Forest Hills. The carrying out of this plan will abolish all the grade crossings on the main line of the Providence division for a distance of 10.87 miles from the Park square station in Boston. The cost of this work, including the widening of the location to accommodate a four-track road (it is now only three-track), as well as the building of the bridges and a number of new suburban stations, is estimated at about $2,500,000.

Another example is to be seen at Brockton, on the Old Colony division of the New York, New Haven & Hartford Road, where the track is to be raised for a distance of about 2 miles and carried under for a little over ½ mile. The railroad is to be raised from 8 to 10 ft. at the maximum, and the highway to be carried under, except at the south end, where the street is to be raised the whole distance of 19½ ft. The present gradients of the railroad are 37 and 25.34 ft. per mile, while the proposed changes introduce a maximum grade of only 32.7 ft. per mile. The whole cost of this work, including new station and other improvements not strictly due to the raising of the track, will be about $1,500,000.

One of the first great improvements of this nature in this country was the work done on Fourth avenue, in New York city, by which forty-five grade crossings were abolished, the whole cost, including the Fourth avenue tunnel, the widening of the road-bed from two to four tracks, and other improvements to adjacent property, being $6,100,000.

The New York & Harlem Railroad Company has recently lowered its tracks in the twenty-third and twenty-fourth wards of the city of New York for a distance of about 5 miles, at the same time providing for two additional tracks, constructing twenty two overhead street bridges, mostly for new streets, and making numerous incidental improvements. The total expense to the railroad was about $2,000,000. Fourteen grade crossings will be abolished by the change. This work was done without interruption to the traffic on the railroad by the following method: A new track was laid at the right of the old location, as shown in Fig. 1. The earth was then removed between it and the old track by teams and steam shovels, until the maximum depth of 12 ft. was reached. The wall shown in Fig. 2 was then put in. The overhead bridges shown in the same cut were then erected, but these were blocked up above their piers on tempo-

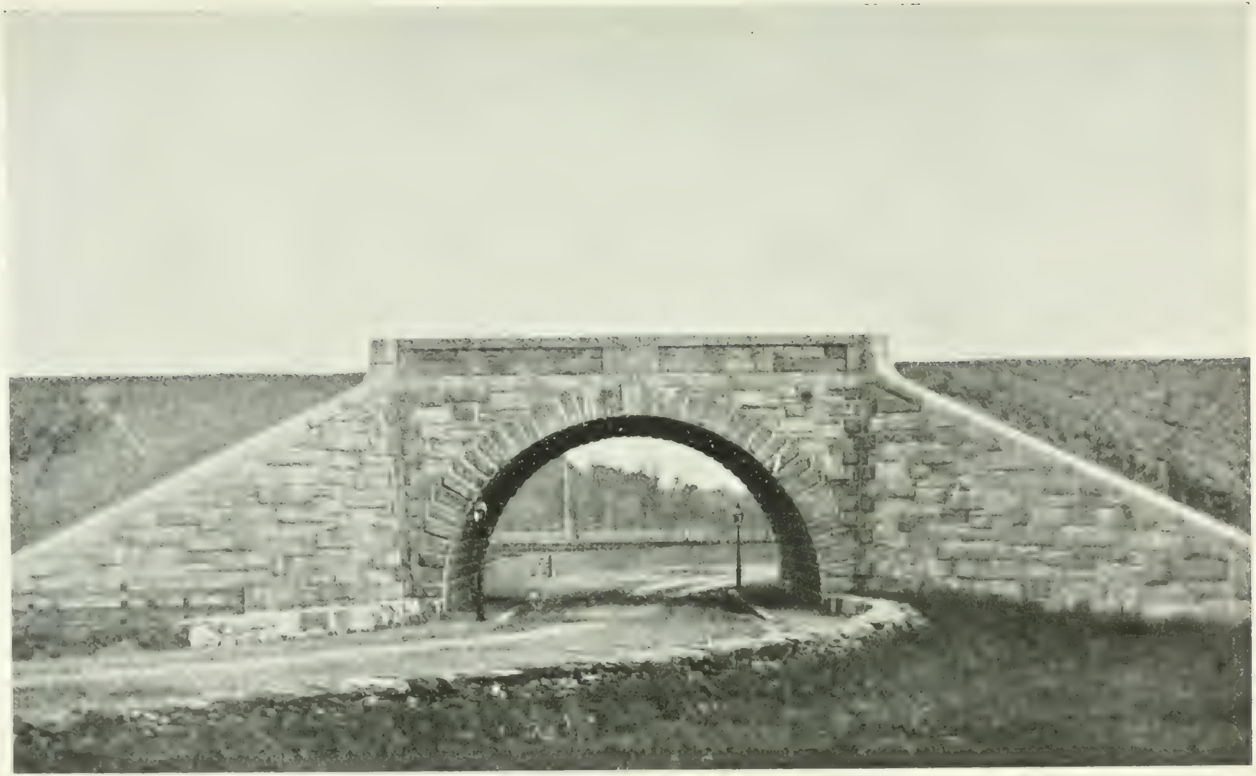


FIG. 7.—NEW BUSSEY BRIDGE, DEDHAM, MASS.

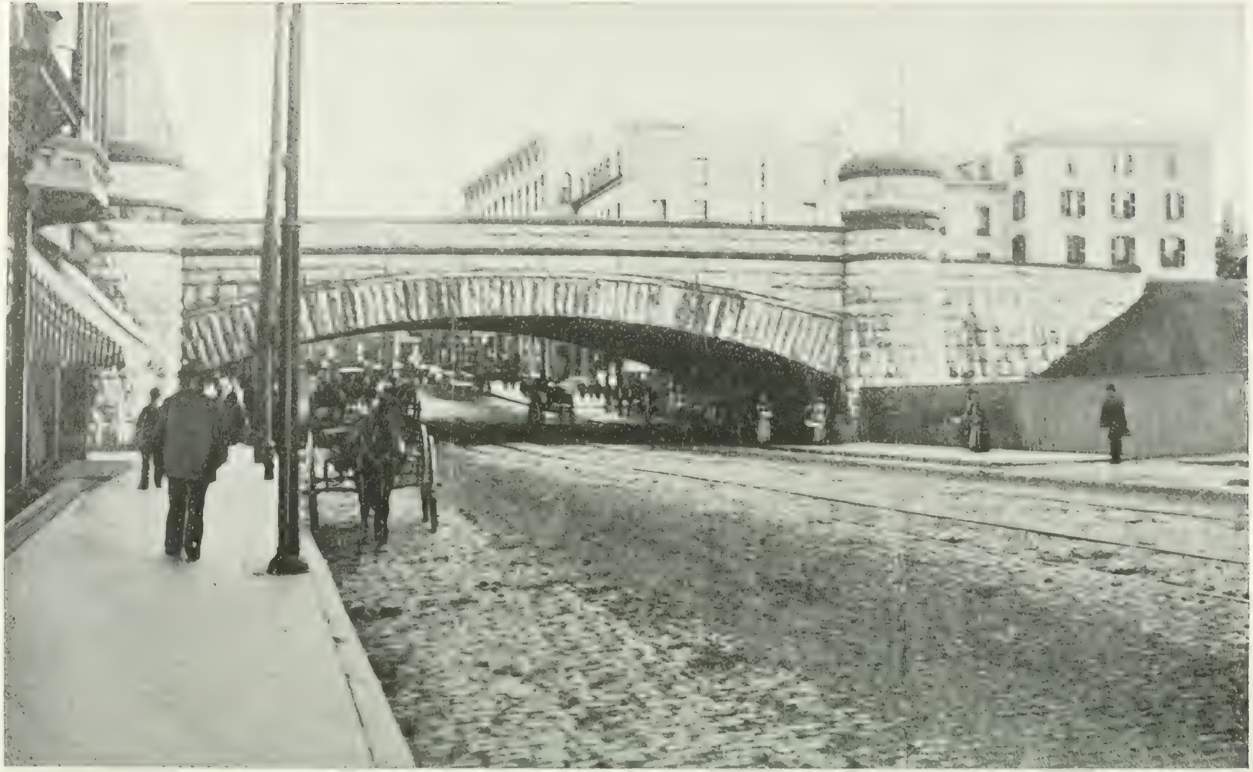


FIG. 8.—BRIDGE OVER MAIN STREET, SPRINGFIELD, MASS.

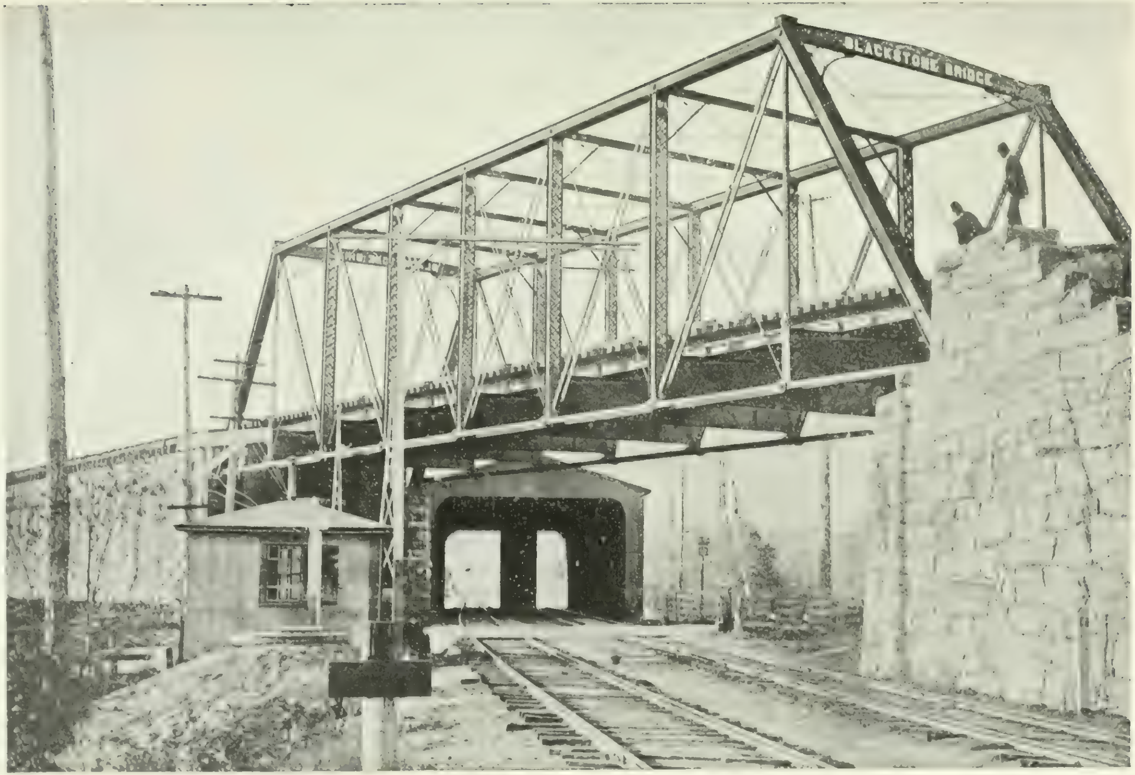


FIG. 9.—A DIFFICULT PROBLEM NEAR BLACKSTONE, MASS.

A highway crosses one railroad at grade and goes under another. Blackstone river prevents carrying highway under both railroads. Views are obstructed in all directions by covered bridges and railway embankments.

rary blocking sufficiently high to clear the traffic on the original tracks. A new permanent track was then laid at the bottom of this new depressed location, graded and ballasted, and used for traffic. The earth was then removed from beneath another track, which was lowered in the same manner, and in some places two tracks were lowered part of the way at the same time ; the highway bridges were then lowered from their blocking into place as shown in Fig. 3, until finally all four tracks had been reconstructed in their new location and the retaining wall built at the left, opposite the location of the original wall. This depression extends from Mott Haven station near the Harlem river, just across from Manhattan island, to a short distance above Bedford Park. By this change the maximum grade of the railroad was decreased from 37.38 to 36.32 ft. per mile.

The New York Central & Hudson River Road, with its four tracks, was raised in Rochester, N. Y., for a distance of about 2 miles, and carried over the streets at a cost of $1,726,617.62, including in this amount $560,074.79 for land and land damage.

The New York, New Haven & Hartford Railroad has abolished nearly all the grade crossings on the main line between New York and New Haven, at a cost of about $10,000 to each crossing. From the figures obtained from these examples and other work of a similar nature, it appears that the cost of changing a four-track trunk line, either by raising or lowering, through a thickly-settled community, is about $500,000 per mile, not including land damages. On lines of less than four tracks this figure is reduced by about $100,000 per mile for each track omitted. The cost of abolishing a grade crossing on a country road, with buildings adjacent, may be estimated roughly at about $10,000 to $12,000, including labor and material on both railroad and highway, as well as land damages, if any. On a village street which is built up with houses, as is usually the case, $18,000 would be an average cost. In a village square, where two or three streets meet and form the square, and the business blocks of the village surround the square, the cost of separation would be about $50,000. In an ordinary city street, built up with ordinary three-story brick blocks, $90,000 would be the average ; and in a city square where two or three streets meet, and a better class of blocks exist, $150,000 each would be the cost. In a city where water, either in canals or rivers, or other extraordinary conditions, are found in close proximity to the crossing this cost may run as high as $200,000 or even $250,000.

The matter of apportioning the cost of the separation of grades is one of grave importance. While undoubtedly the people, in the first place, do not want the location and surfaces of the highways disturbed, preferring to take the risk of crossing at grade rather than go

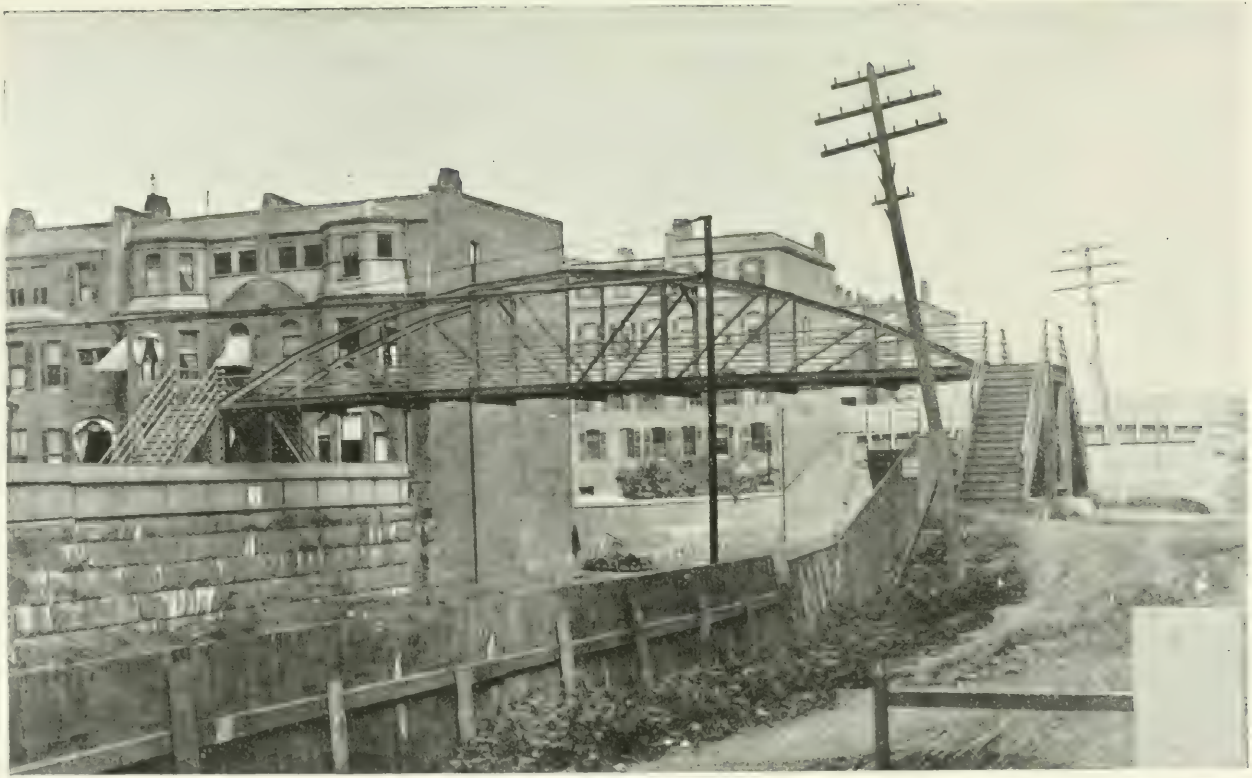


FIG. 10.—FOOT BRIDGE IN FOREGROUND AND HIGHWAY BRIDGE IN BACKGROUND OVER TRACKS OF N. Y., N. H. AND H. R. R., BOSTON.

out of their way to pass under or over the railroad, or to some other location where they could cross more easily either under or over; and while the railroads claim, as a matter of fact, that they can not build their roads except they are allowed to do so at grade, because of the extra cost; and although, because of these two objections, the town, county, and finally the State authorities acquiesce and allow these crossings to be constructed at grade,—still the latter-day view of governmental functions considers that people must not be allowed to injure themselves or each other, and hence, on the broad ground of the greatest good for the greatest number, the authorities are in some degree responsible for the original shiftless construction, and ought to help pay the cost of the change. As a matter of fact, it need not have cost so very much more, except in especial cases, to have built the railroads without any crossings at grade. In proof of this, the Northampton extension of the New York, New Haven & Hartford Railroad, through the town of Deerfield, Mass.,—a distance of about 16 miles,—was built for about $25,000 per mile, without any grade crossings, going over or under fourteen highways. The average cost of construction of a railroad of this class at that time was from $20,000 to $22,000 per mile. As a matter of fact, the actual expense strictly pertaining to the building of these over- and under-crossings, was $67,612.22, or a little over $4000 for each grade crossing so avoided.

The Massachusetts legislature passed, in 1891, a bill which places 65 per cent. of the cost of separating grades on the railroad, 25 per cent. on the State, and 10 per cent. on the city or town, and recently has passed another bill providing that the town or city shall pay more than this 10 per cent. if it requires special methods of construction and extras that will be of sole benefit to the town or add to its appearance in any way. It has always seemed to the writer that the city or town should grade the streets and pay all land and grade damages, while the railroad should do all work within its own location, including the building of bridges, whether to carry the railroad over the highway or the highway over the railroad; and that bridges of the latter class should be kept in repair by the town. The cost of these changes should be apportioned by a commission specially appointed for each case, and very nearly in the proportion of the work to be done by each party; or, preferably, by a permanent commission in each State, which should have authority over such matters, and whose experience, growing from year to year, would become of more use to the State and the people. However this matter of costs is apportioned, the people must sooner or later pay for it, either in the form of additional taxes or higher fares.

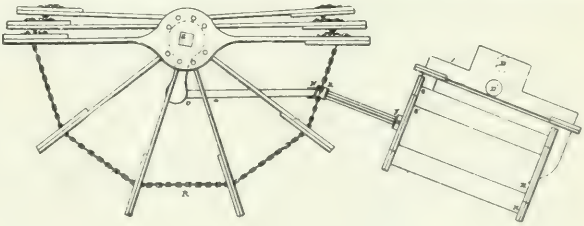
THE EARLIEST TRANSATLANTIC STEAMSHIPS.

I.—1819–1855.

By Samuel Ward Stanton.

ON May 29, 1819, while the little schooner Contract, Captain Livingstone, was sailing quietly along on the Atlantic, in latitude 27° 30′, longitude 70°, the lookout discovered what he supposed to be a vessel on fire, far off on the horizon. The Contract was headed toward the new comer, but, to the surprise of those on board, she passed along quickly and was soon lost to sight, notwithstanding all sail on the Contract was spread. The conclusion was then reached that the strange vessel was nothing more or less than a "steam packet," bound across the ocean.

The vessel in question was the Savannah, a ship of some 380 odd tons, and she was bound to Liverpool from Savannah, having left the latter place on May 26. The Savannah was the first transatlantic steamship. She was built at Corlaer's Hook, on the East river, now part of New York city, by Messrs. Crocker & Fickett, and was at first intended for a sailing packet, but before she was finished was purchased by William Scarborough and others, of Savannah, Ga., and machinery was placed in her. The engine—inclined direct-acting—was built by James P. Allaire, and the boilers by Daniel Dodge. The paddle-wheels were so constructed that they could be taken apart with little trouble and placed on deck should occasion arise, the shaft having joints for that purpose. Skeleton frames, of iron designed to surround the wheels, and covered with canvas, served for wheel-houses. The Savannah's arrival at Liverpool created a small sensation; steaming up the harbor, with sails furled, a full head of steam on, and the American flag floating proudly over her, she no doubt presented an inspiring sight. The trip had occupied 22 days, on 14 of which steam was used. Leaving Liverpool, the Savannah sailed to St. Petersburg, stopping once or twice on the way, and finally returned to Savannah. The machinery was afterwards taken out, and she plied



WHEEL OF THE SAVANNAH.

as a sailing packet between New York and Savannah. She was finally wrecked on the Long island coast.

Soon after the Savannah made her successful ocean trip, a fine large steamer, named Robert Fulton, of 750 tons, was constructed in New York by Henry Eckford, for the route from New York to Cuba and New Orleans. She was a stanch vessel, constructed "entirely of oak, locust, and cedar, and Georgia pine, copper fastened." She had a square, or cross-head, engine, of the type then in use on inland steamers; there were two boilers and two funnels. She left New York for New Orleans on her first trip April 25, 1820, stopping *en route* at Charleston and Havana. She was an entire success, and covered the 2225 miles between New York and New Orleans in an average of 10 days. The New York *Evening Post* of June 15, 1820, contained the following notice of her arrival:

THE SAVANNAH, PIONEER TRANSATLANTIC STEAMSHIP, 1819.

> The beautiful steamship Robert Fulton, Capt. John Mott, arrived last evening, 17 days from New Orleans, *via* Havana and Charleston. At Havana she stopped 2 and at Charleston 4 days. She has aboard between sixty and seventy passengers, and has been at sea only 10 days.

In another notice, on the return of this boat in January, 1821, the *Post* said:

> Steamship Robert Fulton, Capt. Mott, arrived in New York in 8 days from Charleston, having been to New Orleans . . . . 54 days' round trip to New

BRITISH STEAMSHIP SIRIUS, 1838.

The first regular transatlantic passenger steamer; 170 feet in length; 703 tons.

Orleans, averaging 14½ either way . . . . The boisterous season, the rough and heavy weather which she has experienced this trip, must convince even the most incredulous of the perfect practicability of navigating the ocean by steam. Capt. Mott gives her a decided preference over every vessel he ever commanded, both for safety and pleasantness during a gale of wind.

The Robert Fulton ran for three years very successfully; she was then sold to the Brazilian government, to be used as a cruiser, her machinery being removed.

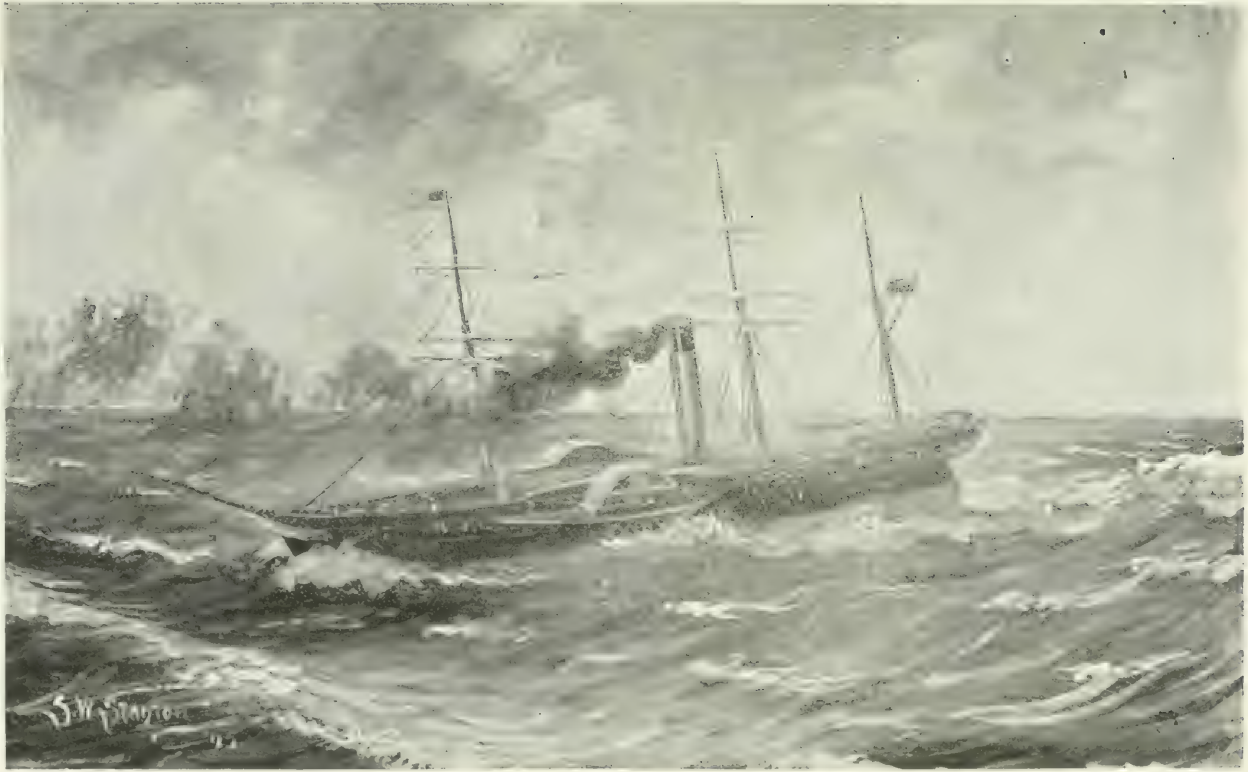
Various small coastwise lines were in operation both in the United States and Great Britain between 1825 and 1835. In 1825 the steamship Enterprise made the trip from England to Calcutta, and it is said that her commander, Captain Johnson, received $50,000 for taking her out. She was of 470 tons burden,—smaller than the Robert Fulton, but larger than the Savannah,—and sailed from Falmouth August 16, 1825. Like the Savannah, her engine was only worked when the weather was fine, it being used 64 out of the 103 days required to perform the passage.

A steamer of 350 tons, called the Curacoa, built in England for a company of merchants of Amsterdam and Rotterdam, ran between Amsterdam and the Dutch West Indies for some time in the later twenties. The Meteor, a British steamship, ran between England and the Mediterranean in 1830; she carried the mails.

Following the Savannah, the next steamer to cross the Atlantic was the Royal William, a 363-ton ship, constructed in Quebec. She made the run from Quebec to London in something over 40 days, leaving August 5, 1833, and reaching Gravesend September 16.

One of the most famous of the early steamships was the Sirius, a small, but stanch, vessel that was sent from Queenstown to New York by the British and North American Steam Navigation Co. on a regular line that had just been established. She left on her voyage to New York on April 5, 1838, with forty-six passengers, and reached her destination April 23. Later in the same day the steamship Great Western arrived from England, and the appearance of these two vessels in the harbor caused great excitement in New York. The Great Western had left Bristol on April 7, thus making the passage in 15½ days as against the 17 of the Sirius. The Sirius had originally been built for coast-wise service in England, but had been chartered in order to anticipate the Great Western, which was about ready to sail on her first trip. The Sirius made two round trips in the line, and was then placed on the route between Dublin and Cork, where she continued plying until January 16, 1847, when she was wrecked. The British Queen, newly built, took the place of the Sirius when she left the transatlantic route.

Another Royal William, built by W. & J. Wilson, at Liver-



THE BRITANNIA, FIRST REGULAR CUNARD LINE STEAMSHIP, 1840.

Length 207 feet; tonnage 1154; the Acadia, Caledonia and Columbia were sister ships.

BRITISH SCREW STEAMSHIP GREAT BRITAIN, 1845.
First iron transatlantic steamer ; 3270 tons

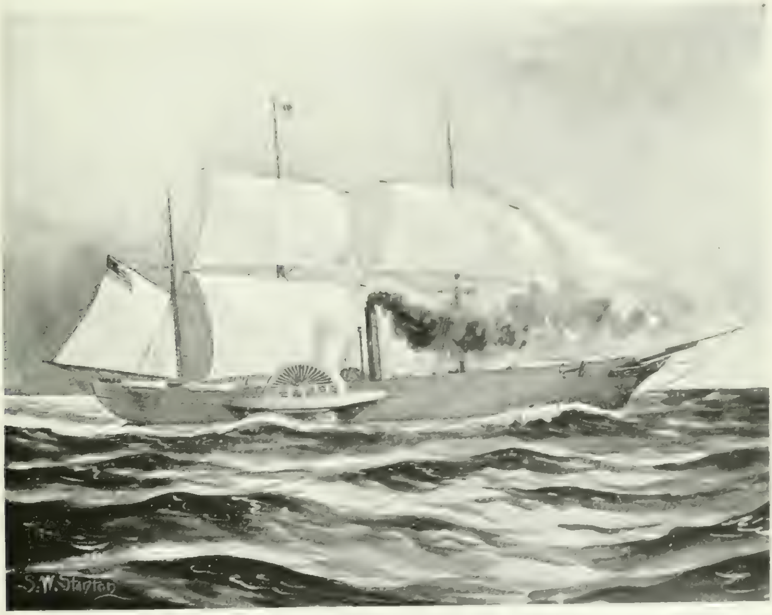
pool, with engines by Fawcett, Preston & Co., left Liverpool July 5, 1838, with passengers for New York. She had water-tight compartments,—probably the first boat so equipped. She made several voyages, and was then succeeded by the Liverpool, a steamer of 1150 tons, constructed by Humble & Milcrest, with engines of 468 horse-power, by Forrester & Co. The company operating her was known as the Transatlantic Steamship Company, and was capitalized at £800,000. The Liverpool went on the line to New York in October, 1838. A few voyages only had been made when she was purchased by the Peninsular & Oriental Steamship Co. and her name changed to Great Liverpool.

The Great Western continued to run for several years, making thirty-seven round trips before she ceased plying to the port of New York. She was sold in 1847 to the Royal Mail Line, and was broken up in 1856. The British Queen, the first of the British & American Steam Navigation Company's own steamers, left Portsmouth, England, on her maiden voyage to New York on July 12, 1839. A companion steamer, the President, came out the next year, and in 1841 was lost at sea ; the British Queen was then sold, and thus the company that held the honor of having sent the first regular passenger steamer to America from Great Britain passed out of existence.

The Great Britain, the first large screw steamer and the first Atlantic steamship of iron, was launched in 1843, but did not cross the ocean until 1845. She made a number of voyages, and was then placed in the Australian service, her rig being changed.

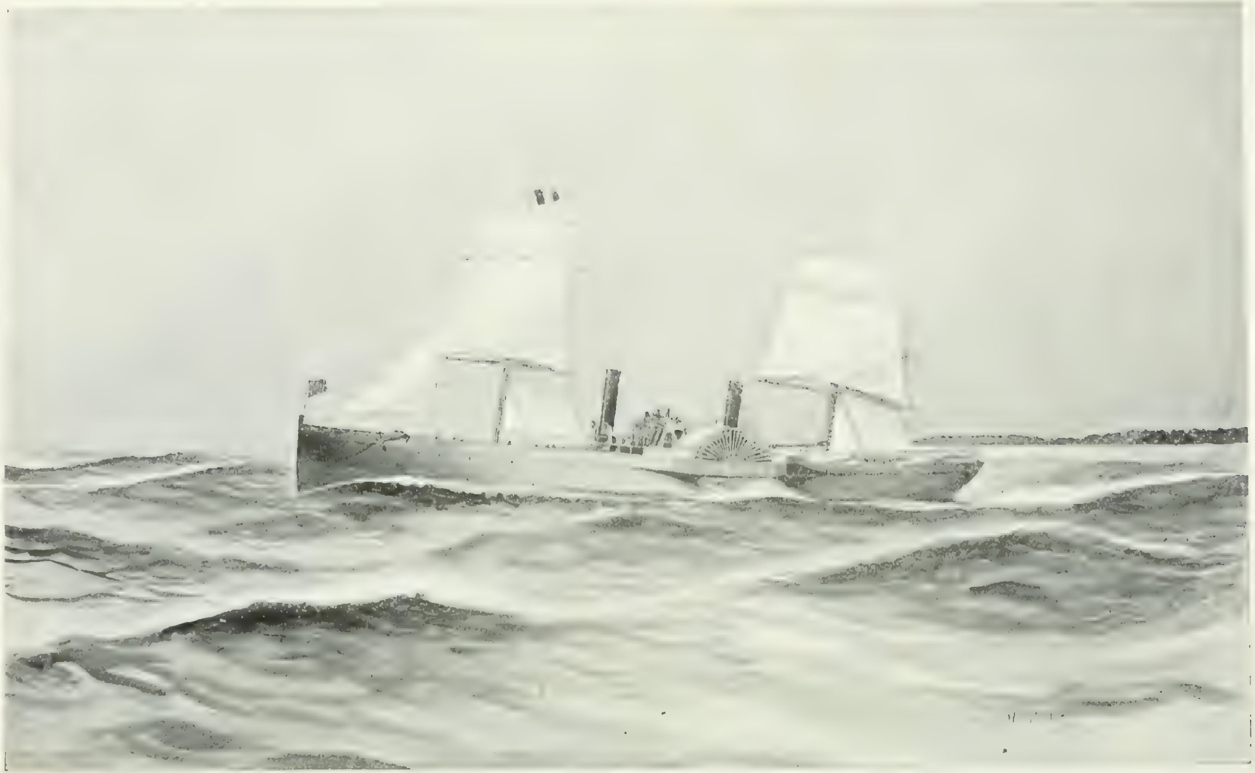
In 1840, Mr. Samuel Cunard, who had gone to England from his native town in Nova Scotia, organized the British & North American Royal Mail Steam Packet Co., the members of the company consisting of himself, George Burns, David McIver, and others. A mail contract between the company and the British government, at £60,000 annually, was no small help to the new concern, which at once ordered four new side-wheel steamships to ply between Liverpool, Halifax, and Boston. Before they were finished, however, the small steamer Unicorn, a Canadian-built vessel, was taken across, and then dispatched to Boston, where she arrived June 2, 1840. The Britannia, the first of the regular Cunarders, was ready soon after, leaving Liverpool on Friday, July 4, 1840, and arriving at Boston, *via* Halifax, on the 19th of the same month. Soon after, the Acadia, Caledonia, and Columbia, boats identical in all particulars to the Britannia, were placed on the line. These vessels plied only to Boston during the first years of their existence, but later a line was run to New York.

After the Savannah, the first American transatlantic steamship was the United States, built in 1846 by William H. Webb, at New York. She made but one round trip, being sold to the Prussian government



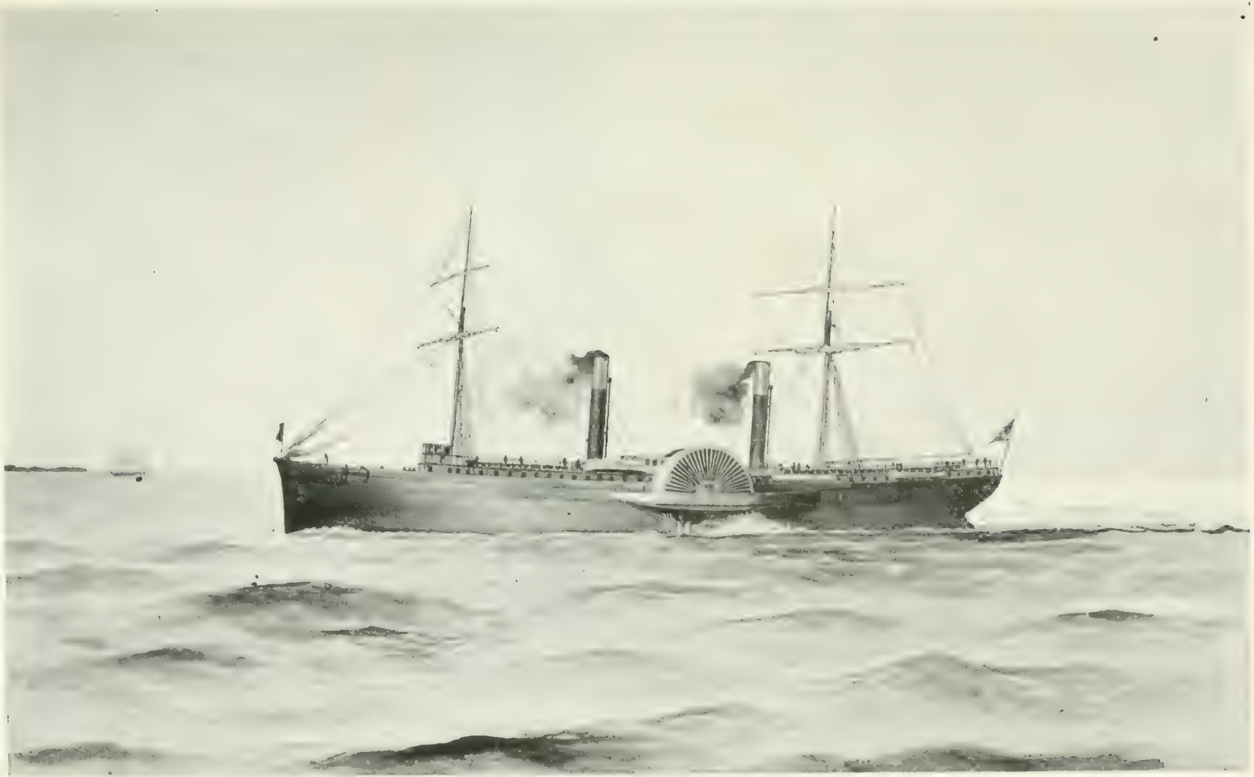
AMERICAN STEAMSHIP UNITED STATES, BLACK BALL LINE, 1847.

Ran between New York and Liverpool; 268 feet in length; 2000 tons.



TRANSATLANTIC AMERICAN STEAMSHIP VANDERBILT, 1856.

The fastest ocean steamship of her time; 331 feet in length; 3360 tons.

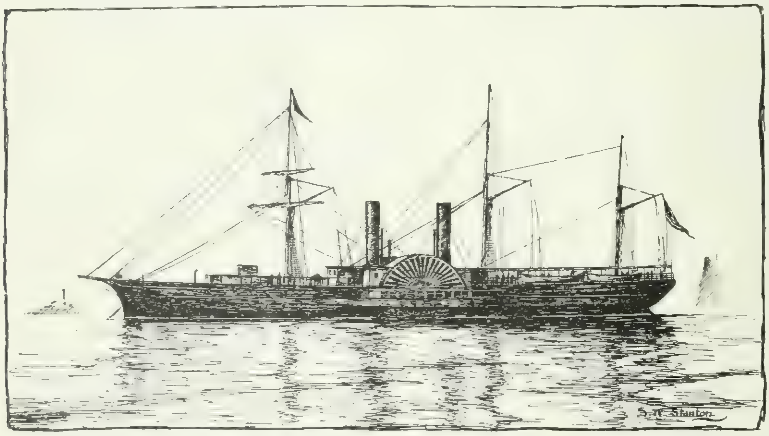


AMERICAN STEAMSHIP ADRIATIC, OF COLLINS LINE, 1856.

The largest and finest ocean steamship that had ever been constructed ; 4144 tons.

to be used as a steam frigate. Following this boat, came the Hermann and Washington, which were built in 1847. They were constructed to ply between New York and Bremen. The Franklin (1848) and Humboldt (1850) were built for the New York and Havre Steam Navigation Co., an American line, and received $150,000 per annum from the United States government for carrying the mails. Both of these vessels were lost; they were succeeded by the Arago, 2260 tons, and Fulton, 2300 tons,—both fine ships.

The most important line of American transatlantic steamships established during these earlier days of steam navigation was the famous Collins Line, Mr. E. K. Collins, proprietor. Four splendid steamships were contracted for, and the government agreed to pay the new line $385,000 subsidy and $415,867 for carrying the mails, on condition that the vessels of the line should eclipse in speed the steamers of any other line. By the end of 1850 four of the finest steamships that had ever been built were in operation, and had at once come to the fore in the matter of speed. These noted vessels were the Atlantic, Pacific, Arctic, and Baltic, each of which cost over $700,000. They were more completely and beautifully finished and furnished than any steamships that had heretofore crossed the Atlantic, and were soon the favorite ships running between America and England. At this time the Cunard Line was receiving, each year as "subsidy," from the British government $735,000, which was raised in 1852 to $866,700, in addition to which the mail pay amounted to over $700,000 annually. The Collins Line received a subsidy of but $385,000 from



AMERICAN STEAMSHIP ILLINOIS, 1851.

Of New York and Central American Line; 267 feet in length; 2100 tons.

the United States government, and a few years later even this was withdrawn, which action, coupled with the loss of the Arctic and Pacific, ruined the company, causing the Collins Line to go out of existence.

The Arabia (1854), of the Cunard Line, was the first of the transatlantic liners to possess but two masts. This vessel was a very fine craft, built to eclipse the records held by the Collins boats, but she failed in this particular, although she was of very fair speed.

A celebrated steamship was the Golden Age, a side-wheel beam engine New York-built steamer of 3000 tons that crossed the Atlantic in 1853. She had accommodations for one thousand passengers, and was magnificently fitted up. From England she went to Australia, making the quickest passage on record. From Sydney she ran to the Isthmus of Panama in 39 days. The Yankee Blade, 2200 tons, an American steamship, made the run in 1854 from New York to Panama (*via* the Straits of Magellan) in 47 sailing days,—the fastest on record to that time.

AMERICAN STEAMSHIP ARAGO, 1855.

Of the New York and Havre Line; length 262 feet; 2260 tons.

In 1850 the Liverpool, New York and Philadelphia Steamship Co. (afterwards known as the Inman Line, and now the American Line) was organized, and placed two steamers, the City of Glasgow and City of Manchester, on the line between Liverpool and Philadelphia. It was an age of wooden, paddle wheel steamers, but the proprietors of this line were far-seeing, practical men, and tried the experiment of making their first two vessels iron screw steamers. The City of Manchester, the second of the fleet, sailed from Greenock for Belfast on her

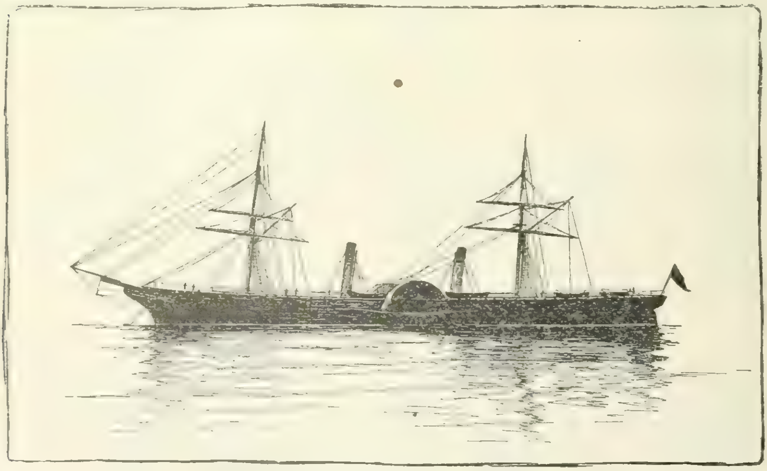
PROMINENT EARLY OCEAN STEAMERS.

NAME.	Ton-nage.	Year Built.	Where built.	Length; breadth; depth in feet.	ENGINES. Diameter of cylinders and piston stroke in inches.	Route, etc.
Savannah (Am.)	380	1818	New York.		Inclined, direct acting, paddle, 40 × 72	First steam vessel to cross the Atlantic, 1819.
Robert Fulton (Am.)	750	1819	"		Cross head, paddle.	New York, Cuba and New Orleans steamship.
Royal William 1st (Can.)	363	1831	Quebec.	160 × 28×17½	Side lever, paddle.	Second steam vessel to cross the Atlantic
Sirius (Br.)	703	1836	Leith	170×25½×18¼	" " 60 × 60	First regular transatlantic passenger steamer.
Royal William 2d (Br.)	617	1837	Liverpool.	145 × 27 × 17½	" " 48½ × 66	Built to run between England and America.
Great Western (Br.)	1340	1837	Bristol.	236 × 35¼×23¼	" " 73½×72	Built for Liverpool and New York trade.
Liverpool (Br.)	1150	1838	Liverpool.	210×30×21	" " 75 × 72	Name afterward changed to Great Liverpool.
British Queen (Br.)	1863	1839	Blackwall.	275×37½×27	" " 71½×72	Built for Liverpool and New York line.
President (Br.)		1839	"		" " 81 × 72	Built for Liverpool and New York line.
Britannia (Br.)	1135	1840	Port Glasgow.	207×34.2×22.4	" " 72½×82	First regular Cunard Line steamship; Liverpool and Boston.
Acadia (Br.)	1154	1840	"	207×34.2×22.4	" " 72½×82	Cunard Line.
Caledonia (Br.)	1138	1840	"	207×34.2×22.1	" " 72½×82	"
Columbia (Br.)	1175	1840	"	207×34.2×22.4	" " 72½×82	"
Great Northern (Br.)		1842		274×37×15	Screw.	Coastwise.
Great Britain (Br.)	3270	1843	Bristol.	322×48×31½	Screw; 80 × 72	First iron screw steamship.
Queen of the East (Br.)	2018	1839	England.	270×45×30	Paddle; 84 × 108	Iron; England and Calcutta.
India (Br.)	1200	1839	"	200×40		Built for India Steam Navigation Co.
Hibernia (Br.)	1422	1843	"	219×35.9×24.2	Side lever, paddle; 77½×90	Cunard Line. Liverpool and Boston.
Cambria (Br.)	1422	1845	"	219×35.9×24.2	" " 77½×90	Cunard Line. Liverpool and Boston
United States (Am.)	2000	1847	New York.	256×50×30½	" "	New York and Liverpool.
Washington (Am.)	1700	1847	"	230×39×31	" " 60×120	New York and Bremen.
Hermann (Am.)	1800	1847	"	235×40×31	" " 60×120	" "
America (Br.)	1825	1848	England.	251×38×25	" " 72½×82	Cunard Line.

Niagara (Br.)	1825	1848	England.	251×38×25	Side lever, paddle; 72½×82	Cunard Line.
Europa (Br.)	1834	1848	"	251×38×25	" " 90×96	"
Canada (Br.)	1831	1848	"	251×38×25	" " 90×96	"
Franklin (Am.)	2400	1848	New York.	263×41×26	" " 81×84	New York and Havre; wrecked 1854 on Long Island.
Ohio (Am.)	2397	1849	"	248×45½×24½	" " 90×36	New York and Central America.
Georgia (Am.)	2695	1849	"	255×49×25½	" " 90×36	New York and Central America.
Atlantic (Am.)	2860	1849	"	290×46×32	" " 95×108	Collins Line. Converted into sailing vessel
Arctic (Am.)	2860	1849	"	290×46×32	" " 95×108	Collins Line. Sunk by collision, 1854; 562 lost.
Pacific (Am.)	2860	1849	"	290×46×32	" " 95×108	Collins Line. Lost in 1856.
Baltic (Am.)	2860	1849	"	290×46×32	" " 95×120	Collins Line. Changed to sailing vessel.
Humboldt (Am.)	2850	1850	"		" " 96×	New York and Havre line; cost $560,000; lost near Halifax in December, 1853.
Asia (Br.)	2226	1850	England.	266×40×27	" " 96¼×108	Cunard Line.
Africa (Br.)	2226	1850	"	266×40×27	" " 96¼×108	"
Illinois (Am.)	2100	1851	New York.	267×40×31	Two, oscillating, paddle; 85×108	New York and Chagres.
City of Glasgow (Br.)	1600	1851	Glasgow.	237×34×25	Screw; 71×60	First Inman Liner, screw; Glasgow and Philadelphia. Lost 1854.
Samuel S. Lewis (Am.)		1851	Philadelphia.	225×32×27	" 60×40	Built for Boston and Liverpool trade; afterward went to Pacific, where she was wrecked.
Arabia (Br.)	2402	1852	England.	285×40×27½	Side lever, paddle; 103×108	Cunard Line.
J. L. Stephens (Am.)		1852	New York.	280×40×26	Oscillating, sidewheel, 85×108	New York and Aspinwall.
Golden Age (Am.)	3000	1853	"	270×43×24½	Vertical beam, sidewheel, 83×144	New York and Australia.
Yankee Blade (Am.)	2200	1853	"	275×32×22	" " 75×132	San Francisco and Panama; wrecked Oct. 1, 1854.
North Star (Am.)	2000	1853	"	269×38×29½	Two, vertical beam; 66×120	Built as steam yacht for Com. Vanderbilt; then transatlantic steamship.
Candia (Br.)	2200	1854	England.	281×40×29½	Screw; 70×48	Liverpool and Alexandria.
Fulton (Am.)	2061	1855	New York.	290×42×31½	Two, oscillating; 65×120	New York and Havre Line.
Arago (Am.)	2260	1855	"	292×40½×31	" " 65×120	" "
Persia (Br.)	3300	1855	England.	376×45×29	Side lever, paddle; 100½×120	First Cunard steamship of iron.
Vanderbilt (Am.)	3360	1855	New York.	331×47½×32½	Two vertical beam engines; 90×144	New York and Havre. Fastest ocean steamer that had ever been built.
Adriatic (Am.)	4144	1857	"	345×50×33	Two, oscillating, sidewheel; 100×144	Collins Line. Largest ocean steamer when she first appeared.

trial trip on July 16, 1851, and averaged 13 miles an hour on the run, the engines—two, driving a double-bladed screw—making twenty-five revolutions a minute. The Samuel S. Lewis, built the same year, in Philadelphia, for the Boston and Liverpool line, was a screw steamer, the propeller of which—14 feet in diameter, with four blades—made one and three-fourth revolutions to one of the crank shaft. In 1852 the Peninsular and Oriental Company adopted the screw on two of their steamers,—the Chausan, of 775 tons, and Formosa, of 675 tons, these boats being attached to their Chinese local trade. These were followed by the Bengal, 2185 tons, and Candia, 2200 tons, for the Indian ocean trade.

The Persia, the first iron steamship of the Cunard Line, was contracted for in 1855, to compete with the Adriatic, then building for the Collins Line. She was 380 ft. in length and of 3870 tons, and was a very handsome and beautifully-fitted steamer. After she appeared, the Adriatic, 4144 tons, was completed, and she is acknowledged to have been the finest that had ever been built. She was the last steamer built for the Collins Line, which went out of existence shortly after her advent. Commodore Vanderbilt established a line of steamers to Southampton and Havre from New York in 1855, putting on the steamers North Star, Ariel, Ocean Queen, and Vanderbilt. This latter, the largest beam engine steamship that had ever been built up to that time, was the fastest ocean steamship of her time. She ran from New York to the Needles, Isle of Wight, in 9 days and 8 hours, and made the passage westward in 9 days, 9 hours, and 24 minutes.



BRITISH STEAMSHIP PERSIA, 1855.

First iron steamship of the Cunard Line; 3300 tons; 376 feet in length.

Following is a summary of the prominent ocean steam lines in 1855:

Liverpool and New York.—Collins Line: Atlantic, 2860 tons; Pacific, 2860 tons; Baltic, 2860 tons; Adriatic [building], 4144 tons; paddle steamers. Cunard Line: Persia, 3300 tons; Africa, 2226 tons; Asia, 2226 tons; Europa, 1834 tons; paddle steamers.

Liverpool and Boston.—Cunard Line: America, 1825 tons; Arabia, 2402 tons; Canada, 1831 tons; Niagara, 1825 tons; paddle steamers.

Glasgow and New York.—Scotch Line: Edinburgh, 2500 tons; New York, 2150 tons; Glasgow, 1962 tons; screw steamers.

London, Cork and New York.—Cork Line: Minna, 1300 tons; Brenda, 1300 tons; screw steamers.

New York and Havre.—Arago, 2260 tons; Fulton, 2061 tons; Union, 2000 tons; Ariel, 2000 tons; North Star, 2000 tons; Vanderbilt, 3600 tons; paddle steamers. Ericsson, 1800 tons; screw steamer.

Antwerp, Southampton and New York.—Belgique, 2590 tons; Constitution, 2500 tons; Leopold I, 2500 tons; Duc de Brabant, 2500 tons; Congress, 2500 tons; screw steamers.

New York, Southampton and Bremen.—Washington, 1700 tons; Hermann, 1800 tons; paddle steamers.

Liverpool and Philadelphia.—City of Baltimore, 2367 tons; City of Washington, 2380 tons; City of Manchester, 2109 tons; screw steamers.

Thus, in 1855, paddle-wheel steamships predominated in ocean service, but a reaction in favor of the screw was about to take place. It was at this time that Great Britain was beginning to attain a degree of perfection with the screw that rapidly proved the superiority of this mode of propulsion for ocean steamers, and after the Persia and Adriatic,—crowning efforts in the way of paddle steamers,—new steamers, with few exceptions, were provided with screws.

SURVEYING AND MAPPING A CITY.

By C. H. Rice.

IF, after buying a wagon-load of coal and storing it in his cellar, the lucky buyer should find that it had turned to gold, he presumably would not go to the coal-dealer to have it weighed to determine how much it was worth. The reason is as plain as a pike-staff. But the same man apparently is perfectly content to hold city real estate of enormous value, the title for which is founded in records prepared by methods which were scarcely accurate enough to justify their use in describing land worth 50 cents per front foot.

For examples to illustrate the considerations set forth in this paper, two cities will be used,—*viz.*, Baltimore, Md., and Roanoke, Va., both of which in times past presented good (or, rather, bad) examples of how confusion may become worse confounded in consequence of inadequate maps and records, but both of which have set other cities in like condition a good example by causing accurate maps and records to be prepared.

Baltimore was laid out many years ago, while Roanoke has grown into a city within the past few years. The records of Baltimore are a perfect tangle by reason of many imperfect copies made from originally imperfect descriptions scattered over many years. It is a singular fact, well illustrated by the condition of affairs in Baltimore, that municipal authorities will take the utmost pains and spare no expense in filing an enormous number of deeds, so that they can be found and consulted with the least possible trouble; but it never seems to strike them that it would be well to discontinue the practice of taking their gold to the coal-dealer to be weighed.

Inaccuracies in land-surveying result from many causes. The chain or tape may not be the length it is assumed to be. Even when its true length under given conditions is known, it may be elongated by excessive tension, and shortened by sag if too little tension is used; and it expands or contracts with every change of temperature. Minor sources of error may be ignored when coal is being weighed, but, if gold is the substance, it is usual to put the scales in a glass case, make them of the best obtainable material, and use them with every possible precaution against inaccuracy.

In measuring city property, worth many dollars per front foot, the first requisite is a standard of known length. At Roanoke the standard is a tape 300 ft. long, which has been verified by comparison with a 300 ft. tape the length of which was carefully determined by the

Missouri river commission. The comparison of the two tapes was made by measuring with each two base lines about 3000 ft. long, carefully taking account of the various conditions of support, tension, temperature, etc.

The standard of length for Baltimore is a line on Mount Royal avenue 500 ft. long, with permanent marks set at convenient intervals. The distances between these marks were measured by a United States Geodetic and Coast Survey assistant engineer with a secondary base apparatus. With this standard, all tapes used on the Topographical Survey of Baltimore are compared. The man who is content to have the coal-dealer weigh his gold will no doubt think that the length of a tape, when accurately known, ends all difficulties, but he who is accustomed to weighing gold knows that even with fine, accurate balances many precautions and safeguards against error are necessary.

In accurate surveying the most essential safeguard against error is a well-arranged triangulation system. When properly connected, with lines and angles measured with tape and transit, such a triangulation system enables the computer to say that "these lines and angles have been determined to such and such a degree of accuracy"; "no error exceeding the set limit of error has occurred"; or, if such an error has occurred, "it is in this line or that angle."

In constructing a triangulation system only a few lines—frequently only one—are directly measured, all the others being calculated from the one or more which have been measured by solving the several triangles of the system. The length of the bases, or measured lines, is therefore a matter of prime importance. The bases at Baltimore, two in number, were measured with a tape 300 ft. long, supported on pulleys at intervals of 20 ft. The pulleys were hung on wooden supports carefully set on line and grade. The tension was measured by spring balances, and the temperature read at three different points on the tape every time it was suspended. The constants for the tape—its length at a standard temperature (62° F.), rate of expansion per degree of temperature, etc.—were determined by many comparisons with the Mount Royal standard. During the comparisons the tape was suspended and used in every way as it was when the bases were measured. The work was done at night, in order to reduce the temperature correction to as small a quantity as possible. Each base line was about 7000 ft. in length.

The measurement of the angles of a triangulation system is a matter second in importance only to the measurement of the bases. With the best of instruments and the most painstaking of observers angles can be only approximately measured. But, by measuring the angles many times and in certain ways, values with a very small amount of error can be arrived at by refined methods of computation.

The intersection points of a triangulation system are too far apart for direct use in surveys for the determination of property lines and the solution of other similar problems. If only a topographical survey, such, for example, as the survey of St. Louis, is desired, the map-work may be founded directly upon a properly-devised triangulation. In such surveys as those of Baltimore and Roanoke the triangulation needs to be supplemented by many additional points, the locations of which are determined therefrom by direct measurement. In order that the check upon these direct measurements furnished by the triangulation may be placed at a high figure, the distance between the triangulation points becomes a matter for careful consideration. Experience at Baltimore and Roanoke indicates that 3000 ft. is a practical average.

If to the triangulation and traverse systems above mentioned a system of precise levels is added, a foundation for every kind of mapping and calculating is established. If proper precautions are taken for preserving the marks, this foundation remains good for all time. The matter of preserving the marks is a somewhat expensive one. At Roanoke granite monuments, with a copper wire leaded in for the mark, were buried deep enough to escape the possible influence of frost. At Baltimore stone monuments, asphalt blocks, and iron pipes have been used, besides many surface-marks upon sidewalks and curbs.

The character of the superstructure to be built upon the above-described foundation depends upon the use for which it is intended. In a great city it ought to provide for all the multitudinous requirements of complex public and private interests.

The city of Roanoke was confronted with the all-important problem of adjusting property and street lines, and hence the maps were drawn on a large scale and the field-work was executed by methods enabling all the intricate calculations necessary in effecting such an adjustment to be made.

At Baltimore the same complex problem is again present, and many additional ones as well. A large territory has been annexed to the original city, and its system of streets must be projected to the best possible advantage. A sewerage system adequate to the needs of a great city must be designed. A basis for the records of the various branches of the city government must be provided, and the general public must be enabled to procure the various maps which the requirements of trade, comfort, and luxury demand.

The maps ordinarily needed by any city, and the uses to which they may be put, will be somewhat as follows:

First. A general map, embracing the entire city, on a scale of about 500 ft. to one inch, showing horizontal contours at intervals of 5 ft., streets and their names, blocks and their numbers, the various political and governmental districts, public and important private buildings, and lines of transportation and travel.

Upon this map the broad, general lines for public improvement may be projected,—such as streets, sewers, etc. It will serve the various branches of the city government for an index. For example: the water board can use it to show the general location of water mains, fire hydrants, etc. Corporations, such as gas, electric, and street-railway companies, will make much the same use of it. It will serve the general public as a wall map. Such a map will be the last one to be prepared, because it is, in fact, a compilation from all the others.

Second. Maps on a scale of 200 ft. to 1 in. should cover about 1 sq. mile for each sheet. They should show horizontal contours at intervals of 5 ft.; all streets and alleys; all buildings and fences; and the conditions of the ground,—whether wooded, grass, or cultivated.

Upon the separate sections of this map the details of street locations and drainage problems can be more closely studied than upon the general map. If the contours are as well-located as they have been at Baltimore, reasonably accurate profiles may be prepared from them.

The general public will use a great many copies of this map. Every real-estate owner ought to possess the sheet upon which his property is located. From such a map the owners of large tracts, handsomely laid out, like many in the annexed district of Baltimore, may have relief models prepared, thus enabling the landscape gardener to study methods of improving and beautifying their grounds to far better advantage than by any other means. A few relief maps of this kind have been prepared at Baltimore, and their striking beauty and utility is apparent to every one who sees them.

Third. Maps on a scale of 100 ft. to 1 in. may be conveniently made to embrace ¼ sq. mile (at Baltimore ⅙ of a sq. mile is the size used). Nearly everything upon the surface of the ground should be shown, to say nothing of much that is underground,—such as sewers, gas and water mains, electric conduits, etc. Most engineering problems may be worked out in detail with the assistance of such maps. The various departments of the city government will have occasion to use them constantly. As an example, the street department can show the character and condition of the pavements in different streets, the date and by whom laid, and much other information of like character,—matters constantly wanted by committees of city councils, contracting firms, or private individuals.

Fourth. Maps on a large scale (40 ft. to 1 in. as used at Baltimore and Roanoke) cannot, of course, cover a very large territory without becoming unwieldy. Twenty-four sheets to the square mile has been found a convenient size. The dimensions of blocks might be allowed to determine the matter, by so arranging the sheets that complete blocks would always be shown on each sheet.

Such maps ought to contain everything a map can be made to show, even to the ground-plans of buildings, materials of which the buildings consist, number of stories, and owners' names.

At both Baltimore and Roanoke the information for compiling these maps has been taken in such a way that all kinds of calculations may be made from them. The relation between the boundaries of properties as they actually exist on the ground, and as they exist in the descriptions given in deeds, may be worked out, and the information to be used by the proper legal authorities in adjusting such matters may be presented in the best and most accurate way. The objection has been raised that such information will unsettle many titles, and promote litigation. The idea upon which this objection is based is erroneous, since a title under an existing wrong description is necessarily unsettled, while a proper adjustment of the discrepancy will settle it.

If a piece of cardboard be assumed to represent a block of city property, and this be cut up into small pieces with a sharp knife to represent the lots, everything can readily be fitted together without gaps or overlaps. This is a case parallel to perfect deed descriptions. If, now, the shape and size of each separate piece be distorted by stretching, contracting, and warping in every conceivable way, the conditions as they often exist in the deed descriptions will be presented. Of course the sections will not fit together.

The problem of adjusting erroneous boundaries is one of the most complex and intricate that can well be conceived of. In many cases the most proper course is to accept the lines as shown on the ground, and prepare new descriptions to fit the facts, regardless of the old descriptions. A mutual confirmatory agreement among owners will make such an adjustment a perfect one. In writing deeds it is a general custom to avoid one source of inaccurate descriptions by calling for natural objects. As long as the natural object exists, or its location can be found, this is all very well; but, after it is lost, and every deed which corners upon it gives a different location for it when run out by the surveyors, then the trouble commences. Until some broad scheme for general adjustment is devised and carried out, errors once started constantly tend to accumulate and go from bad to worse, until, as at Baltimore, there exists a condition of apparently hopeless confusion. The descriptions are copied from one deed to another by lawyer's clerks, with whom the only question is one of title, not whether the description is a correct one or not. What matters it to them if the recorded description of some adjacent lot covers part of the land conveyed by the one just written? There may be a profitable case in it for some brother lawyer, if it gets even that much thought.

In many cases the original muddle has been greatly aggravated by city officials, who, when retiring from office, claim the notes taken during their incumbency, as private belongings, thus robbing the public of what is really its own property. Instances are far too frequent in which employees of the city government have prepared notes, as an example, of the location of sewer connections, and have claimed the notes as their own, not even furnishing the city with a copy. The mischief possible in a few years by such gross dishonesty is very great, and in many instances there is no way in which adequate punishment can be meted out to the evil-doers. Such troubles arise in a large measure from a lack of system and proper records. With maps and records as outlined in this paper, and a proper system of keeping all records up to date in the various departments of city government, all such difficulties would be avoided.

The filing and indexing of maps and notes is a matter of detail which requires more careful attention than it usually receives The mass of information collected during a survey is so great as to be perfectly bewildering unless systematically indexed and filed. At Roanoke the maps and notes are in charge of the city engineer, and are filed in a fire-proof vault in metallic cases built especially for them, so that everything is easily kept in its assigned place and may be found at any time without trouble.

The survey of the city of Baltimore, which has been so frequently referred to, is still in progress, with Col. H. T. Douglas, M. Am. Soc. C. E., as chief engineer.

The sum of $125,000 was appropriated at the outset for this work. The city council has recently passed another appropriation for $31,000, to continue the survey another year. The chief engineer estimates that still another appropriation of like amount will be necessary before the maps and notes can be considered ready to be turned over to the proper department of the city government and made a matter of public record. When the work of this survey is fully completed, Baltimore will have a set of maps and accompanying records second to those of no city in the world.

REVOLUTION IN STEEL-MAKING.

By William Metcalf.

WITHIN little more than a century all steel, except a little Wootz, was made from wrought iron by what is known as the cementation process, and its uses were limited. Early in the last century Huntsman invented the process of producing steel by the fusion of wrought iron and blister steel in crucibles, the product being known as crucible cast steel. This product was so superior that the use of steel was increased greatly, and all wants seemed to be supplied. For about 100 years there was little or no advance in the art of steel-making, except in increased skill and accuracy, and improved machinery. During this time the production of cast iron and wrought iron had increased enormously; the invention of railroads, iron ships, and iron bridges caused an immense demand for wrought iron in all forms, especially in heavy plates and beams, which was well and promptly met and filled by skilled manufacturers in Europe and in the United States.

The advances made in the use of iron were so great and so rapid that the time covered was known, popularly and properly, as the "Iron Age." The art of iron-making had reached its limit both in quality and in magnitude of pieces, since all iron was produced primarily in little balls that could be handled by one man, and these had to be piled and pasted together piece by piece, until the size required was reached, the size being necessarily small because of the mode of working.

No one seemed to expect much advance, and no one appeared to think of any advance in steel-making until the demands of war, requiring heavy guns, led a genius, now Sir Henry Bessemer, to conceive the idea of producing cast steel in large masses by blowing air through molten cast iron. About the same time another genius, Sir Wm. Siemens, invented the regenerative gas furnace,—an invention of importance hardly exceeded by that of Watts and certainly not by that of Bessemer.

A Frenchman named Martin adapted the Siemens furnace to the melting of steel in bulk, the product being known first as Siemens-Martin steel; in the last few years this name has been replaced by that of "open hearth steel." In this way the world was given two new products,—bessemer steel and open hearth steel, which in 30 years have led to such enormous advances in the use of metals and in the power of engineers that the time is well named the Age of Steel and the *generation of revolution.*

With the demands were found the men,—men of genius, skill, and energy, many of whom, like Holley, Jones, and others in our own country and in England, shortened their lives in the intensity of their efforts to keep in advance of all demands: they have done their work and made for themselves imperishable records, while the world, greatly benefited by their efforts, moves on to greater achievements.

It is the object of this article to explain as well as may be, not the relative merits of these steel processes with a view to invidious comparisons, but the different fields of usefulness which each may be expected to occupy, each being adapted best to its own field.

Before proceeding, it is important to explain that all of the constituents of steel are named in hundredths of 1 per cent., the rule being, except in a few special steels not under consideration here, and in very high carbon steel, that no element of steel save iron is present in greater quantity than 1 per cent.; in fact, all except carbon and manganese are present in quantities of less than 1/10 per cent. So that .10 carbon, .10 phosphorus, etc., mean 1/10 per cent., and the term "point" means 1/100 per cent.; in speaking of differences of points of carbon, for instance, twenty-five points means 25/100 per cent., and so for all of the elements.

Although bessemer steel was invented primarily to produce large masses of steel for heavy ordnance and for armor, failure in that direction was as ignominious as was the failure of the instigator of the invention, Napoleon III, to establish imperialism; the invention itself, however, was so simple, and its potencies were so great, that men of skill and energy in all industrial countries took up the process, and by persistence overcame in a few years the chief difficulties first met with

The one crowning success of bessemer steel was, and is, the production of strong, practically homogeneous, and durable steel rails. It is well understood and acknowledged generally that to the bessemer steel rail is due the great advance in railroad practice, resulting in more powerful engines, larger and more comfortable cars, increased speeds, greater safety, and much lessened cost. The higher speeds and heavier engines required stronger boilers in the engines and stronger bridges to carry the heavier loads. This demand was met in a measure by the iron makers, and in a still greater degree by the bessemer steel makers, but neither were entirely satisfactory. It was difficult to make iron of the necessary strength, ductility, and soundness, especially for boiler plates; and, while bessemer steel could be made with these necessary properties, numerous failures, mysterious at the time, led cautious men to be fearful of adopting the new material. In this emergency crucible steel was tried for boiler plates with complete success, but the cost of the material was so great that persistent efforts were made to find a cheaper satisfactory material. This was found eventually in open hearth steel, and so the open hearth process scored its first great victory and came into prominence. Those crucible steel-makers who from excess of caution had refrained from building boiler-plate mills were undisturbed, and those who had been progressive enough to build such mills promptly supplied themselves with open hearth furnaces to produce their ingots.

During this time there had been many applications for bessemer steel as material for bridges, ship and tank plates, and machinery parts. This field was occupied so completely that in a few years iron bridges and ships were hardly thought of, except by a few ultra conservative people ; and, in regard to machinery, it became a fact that mowing machines, for instance, which a few years before contained but one piece of steel, all other metal parts being iron, now contain but one piece of iron, all other metal parts being steel.

In the beginning the bessemer process experienced a succession of disastrous failures which almost led to its abandonment. It was soon discovered that neither phosphorus or sulphur were reduced in this intense burning process ; both of these elements, contained in the cast iron, remained in the steel. This difficulty was removed by the use of iron low in phosphorus and sulphur, the limit for phosphorus being fixed at .10 ; so that what is now known as bessemer pig is iron guaranteed not to contain more than .10 phosphorus. The limit for sulphur is that it shall be so low as not to cause red-shortness, and manufacturers may be depended upon to attend to this, as no mill man wishes to be annoyed with red-short material.

An insufficiency of heat was another serious trouble, which was overcome by an increase of silicon content, as it was found that the combustion of silicon produced intense heat ; a farther advantage was found in the fact that high silicon tended to low phosphorus.

The greatest difficulty of all, perhaps, was the presence of large quantities of oxids, which remained in the steel, producing excessive red-shortness and general badness. This was overcome by the introduction of melted ferro-manganese after the blowing was completed, the manganese taking up the oxygen sufficiently to leave the remaining steel workable and good.

These chief difficulties having been removed, the advance in the production and use of bessemer steel was marvellous,—unparalleled in the history of industrial arts. Still there were startling and apparently mysterious failures that frightened the timid, until experience gave knowledge, and knowledge guided the skilful and careful makers to better work, so that the failures became rare, confidence was assured, and both makers and users felt safe within well-established limits.

The chief limitation to the bessemer process is in the entire absence of power to manipulate beyond very narrow limits, for the reason that, when a heat is blown, the sources of heat are exhausted, and the steel must be put into ingots before it becomes too cold. If it be overblown, the excess of oxids cannot be eliminated; if it be underblown, or if it be a cold heat, there is no means of increasing the temperature; if it be "wild," sufficient time cannot be given to allow it to settle, for it cannot be "killed": and, if steel be not practically killed in the melting, the resulting ingots will be as porous as a sponge—honeycombed. Notwithstanding, the bessemer process is simple, efficient in good hands, and very cheap: it has its great field of usefulness, and it has come to stay. Good, mild bessemer billets, stronger and tougher than the best wrought iron, have sold lately for less than $16 per ton of 2240 lbs. Makers of wrought iron need no farther hint than this.

Basic bessemer steel led to the belief for a time that the field for the product would be widened greatly, and it has been enlarged greatly by enabling the English and continental makers to utilize their phosphoric ores; but the quality of the basic is not so much better than the acid as to have made much change in the use of the product. It is very different with the basic open hearth product.

In using the basic bessemer process it is necessary to continue the blow a few moments after the carbon is burned out, and this "afterblow" is liable to be carried a little too far, causing burning of iron and excess of oxids: the process, too, is subject to the same limitations regarding the power to manipulate as is the acid process, and therefore the general application of bessemer steel has not been widened greatly by the invention of the basic process.

The open hearth process was now established firmly, supplying excellent boiler plate, sheets, and all manner of mild steel for many purposes. It also became useful in the production of a good quality of steel castings. This latter industry alone has become a great boom to engineers, supplying them with strong, tough castings of almost any desired shape, overcoming many troubles which had been caused by the weakness of cast iron and the expense of difficult shapes in forgings. The sand bottom, or acid process, was subject to the same limitations as the bessemer acid process, chemically speaking; neither phosphorus or sulphur were reduced, only silicon and carbon being subject to modification at will.

This made it necessary to insure that the charge should contain only so much phosphorus and sulphur as were allowable in the finished steel. Aside from this, nearly all of the troubles known in the bessemer process disappeared in the open hearth; the source of heat in the open hearth being extraneous, temperatures can be increased or decreased at will. If, when a heat is melted, it be not just right, it can be held in the furnace indefinitely,—cooled down, made hotter, or held even, as may be desired. The steel may be melted dead, so as to remain quiet in the molds and make sound ingots or castings. The carbon, silicon, and manganese contents can be controlled thoroughly in mild steel, and there need be no over-melting or burning.

In high carbon steel there seems to be more difficulty in producing uniform results, so that for some years bessemer steel held the preference for steel for springs, battering tools, etc.

The open hearth is a much slower process than the bessemer, and for a large output requires a rather larger investment and more skilled labor than the bessemer; therefore it does not seem likely to drive the bessemer from its own peculiar field.

The basic process, so successful in the bessemer, is even more so in the open hearth, for, the source of heat being extraneous, it is not necessary to introduce phosphorus in the open hearth as a fuel; and it is found also that phosphorus may be reduced considerably before the carbon is burned out, so that it is possible to produce steel of 1 per cent. carbon or more from a charge containing .10 phosphorus, and have the steel contain less than .05 phosphorus, although it be melted down only to 1 per cent. or more carbon, requiring practically no recarbonizing. This fact has given the basic open hearth an enormous field of usefulness which was not successfully occupied by the bessemer.

It is possible in the basic open hearth to melt down to any desired carbon, and not go any lower, so that there need be no over-melting in any case, if ordinary care and good judgment be used.

Sulphur is not yet reduced in the basic open hearth, and it is necessary to start with low sulphur in the charge. The reduction of sulphur ought not to be an insoluble problem, and here is a field in which the coming generation of metallurgists may exercise their skill.

Armor plates, great guns, large structural shapes, and heavy castings are now made by the open hearth process to meet all reasonable requirements. Common cutlery, files, cheap hatchets, good battering tools (such as hammers and sledges), springs, and tire of all sorts are now made almost exclusively of bessemer or open hearth steel, the advantage in uniformity and strength being rather with the basic open hearth. At the time of the invention of the bessemer process all of the articles mentioned in the last sentence, and many more, were made of crucible steel, or of German steel; and although now, as always, crucible steel of inferior chemical quality is stronger and better in the tempered condition than the best of bessemer or open hearth steel, yet the latter, being much cheaper and generally good enough, have almost entirely supplanted crucible steel for all except high-class tools.

A few years ago there seemed to be a wide gap between crucible steel and the ordinary bessemer or open hearth steel, to be filled by something better in quality than the latter and less in cost than the former.

A careful inquiry over the whole field both in America and Europe, and a careful consideration of the opinions of many of the leading steel-makers of the world, led a prominent firm of crucible-steel-makers to decide upon and build a three-ton bessemer plant, as the bessemer seemed to them more likely to fill the gap than the open hearth. The basic open hearth was not then developed by Americans, although used largely for the common grades by Europeans. The plant was built at an expense of about $80,000, and started. Inside of a month another prominent steel-maker laid down in the yards of the crucible men billets of very high quality at a price less than the cost of the raw material that would have been required in the bessemer to produce billets of even quality. These were basic open hearth billets, the process having been developed while the little bessemer was building. The bessemer plant was shut down immediately, but the $80,000 was not all lost; the vessels were torn out and sold as scrap, cranes were shifted, new ladles and pits were arranged, a small basic open hearth furnace was built, and now the little plant is running successfully. The "gap" has been filled to the entire satisfaction of consumers, and crucible steel is relegated to the higher walks, where the requirements of great strength, fineness, and endurance outweigh questions of cost.

The fact remains hardly disputed that crucible steel of chemical inferiority, but of rather high carbon, is, in the tempered condition, greatly superior to the best of bessemer or open hearth steel; this is not a mere mystery; it is not due to ghosts or to hobgoblins; it has certainly a discoverable and removable chemical or physical cause. It seems now almost certain that it is due to one or all of the three elements, oxygen, nitrogen, and hydrogen, all of which are introduced in steel in the bessemer and open hearth processes in much greater quantities than in the crucible process. It is known that they are there either as elements, or as oxids, cyanogen, or ammonia; in what way they produce bad effects, or how they may be removed, is not known. Here is a large field for metallurgic engineers. Other great revolutions may come at any time and in ways as entirely unexpected as many of the great changes of the past.

The conclusions from what has been written may be summed as follows:

1. Wrought iron can never again be a leading metal of construction, since a stronger and better material can be produced at much less cost than is possible to the laborious hand-worked system of making wrought iron; all men should rejoice if mankind could be released forever from the heavy, exhausting labor of the puddler.

2. The field of the expensive crucible has been narrowed greatly, and limited to the finer requirements of the arts; it will hold this field until future developments shall remove the last elements of weakness from the cheaper processes; when that time comes, crucibles will be used no longer for making steel.

3. The bessemer process is so exceedingly simple, handy, and cheap that it does not seem likely that the open hearth process will ever drive it out of use or prevent its development.

4. The open hearth process, and especially the basic, is so well in the front as to certainty and quality, and it is so economical, that it must be given precedence, and engineers may feel easy as to their ability to get almost anything they need.

5. Poor crucible, bessemer, and open hearth steel will always be produced in large quantities, and buyers will be found for them as long as greed and ignorance are to be found among men; and there will always be men of conscience who, with a due regard for character, will do the best possible work. The wise investor and sensible engineer will know these latter, and those who will may have good material and be safe in using it.

Revolutions sharp, sudden, expensive, and unexpected, have been so numerous in the last 30 years that the men who have led in the struggle have become gray at a time when ordinarily much of the spring of youth, and all the vigor of prime, should still be left to them; many have fallen by the way side, and many are gone over to the great majority; they have done their work, and they have done it well; the foundations are established so firmly that the ordinary works of to-day would have been wonders 30 years ago, and wild speculations of dreamers 50 years ago; the achievements of the next century will be established on these same foundations; art, skill, and science will beautify the superstructures, and the workers will look back with admiration upon the records of the pioneers.

The art of steel-making is so well established now that engineers and investors can go on with their work safely and economically, and it seems as if all requirements were met so well that there might be a period of rest from revolutions, and that leaders could devote themselves to the perfection of organization and the production of sure results. Those who are in the front, however, see clearly that much is yet to be done, and they are not so optimistic as to look for quiet times.

ONTARIO DRAIN TUNNEL AND ELECTRIC PLANT.

By C. E. McKay.

THE adverse financial conditions which have prevailed during recent years have cut with peculiar keenness into the profits of the silver mining industry, and those mines which can now be profitably worked are exemplifications of the survival of the fittest. Their vast mining and milling plants call for the exercise of almost all branches of science and engineering. Probably no mine system in the world possesses more features of interest and instruction than the Ontario and Daly mines, worked in conjunction under one ownership, and located near Park City, Utah, in the Wahsatch range.

The recent completion of the Ontario drain tunnel and the utilization of its waste water to furnish electric light and power for the numerous works and mills of the companies present some features which seem to justify description, and which may convey valuable lessons to those engaged in similar projects.

The Ontario mine was discovered in 1872 and has been continuously worked since that time, its owners having purchased and acquired a vast amount of land for the purpose of extending their territory and controlling the ore bodies along the veins therein.

The Ontario has four vertical shafts, only two of which are at present actively used, the several shafts having been sunk in order to reach the ore bodies in the most convenient and economical manner. The shafts now used are No. 2 and No. 3, the former being at present 1500 feet in depth and the latter 1100 feet. The underground workings of these mines have attained such vast dimensions that, if placed end to end, they would form a continuous tunnel nearly 60 miles long.

The chief difficulty and expense encountered during the operation of this mining enterprise has been the disposition of the water which pours into the underground excavations from subterranean reservoirs and streams. Two means only existed by which this could be controlled, these being the continual operation of large and numerous pumping engines, and the cutting of tunnels from the lowest available point of the workings to some surface location which afforded natural drainage for the final disposition of the flow. Either method, of course, involved great expense.

When Ontario shaft No. 3 had reached a depth of 600 feet, the quantity of water had become so formidable that considerations of economy impelled the management to run a drain tunnel from the bottom of that shaft to a point nearly a mile distant, through which the drainage was carried off. For several years this tunnel proved equal to the requirements and resulted in great saving to the company, but, as the shafts went deeper and the lateral workings extended, the water again became an intolerable burden, and far more serious than ever before, for at this time the Ontario was operating much deeper than any of the surrounding mines, and the ramifications of its underground work had assumed such proportions that not only had the local water greatly increased, but the mines located round about, and in fact the entire neighboring country, had begun to drain into the lower workings of the Ontario. In one case a large adjacent mine which had been unable to contend against the water, and had been closed down on that account, became absolutely dry and remains so to-day.

When the Ontario had reached a depth of 1200 feet, it became necessary to run a new drain tunnel, and to locate it at a depth sufficient to provide for extensive operations in the future.

The topography of the country is such that the utmost thought and careful consideration were demanded in finally deciding as to the direction of the proposed tunnel and the location of its mouth. The estimates as to time and expense involved were most difficult to form, and the conditions involved were complicated and uncertain. The decision, as finally made, was to run eastward from the 1500-ft. level of No. 2 shaft, the total length of the tunnel being approximately 3 miles. It was expected that 6 years would be required to complete the work, and that the cost would approximate $500,000.

Work was begun on this tunnel July 25, 1888, at the east end. The first 300 ft. were driven entirely by hand, during the erection of machinery at the mouth of the tunnel. The plant consisted of boilers and engines, a Root blower, used as an exhaust for sucking foul air and powder smoke from the face, two large air compressors supplying Ingersoll drills, and a saw-mill for cutting timbers used in the tunnel. All the timber was hauled by wagon from 15 to 20 miles, being shaped and fitted at the tunnel mouth.

During November, 1891, a tremendous body of water was encountered, which drove out the men from the face. Bulkheads were useless. Nothing could restrain the flow, and all that could be done was to wait for the water to exhaust itself. The volume was so great that for a distance of 9000 ft. the track had to be raised, because of the insufficient water way, and parts of the track were entirely washed out. Seventy-one days were lost before work at this point could be resumed.

Again in May, 1892, a similar experience stopped all work for 55 days. These two occurrences were preceded by the loss by fire of the buildings at the mouth of the tunnel, which caused a further delay of 2 months for reconstruction. The total loss of time during the construction of the tunnel, from all causes, amounted to 413 days.

In order to relieve the water pressure along the main line of the tunnel, side drifts, aggregating 644 ft., were run at various points. Ten switches for the passage of trains were also cut double the normal width of the tunnel, making a total length of 1593 ft. of additional work.

Owing to the nature of the ground along the line of the tunnel, it was considered impracticable to sink an intermediate shaft, but, in order to hasten the work, a force of men was set to drive eastward from the 1500-level of No. 2 shaft, the idea being to push forward until the two headings should meet. After running 270 ft., a flow of water was encountered which bade fair to endanger the entire mine by flooding the pumps; therefore work was discontinued at the west end. After more than six years of unremitting labor, mishap, and disaster, the final connection of the two headings was made on the night of October 7, 1894. The east and west headings of the tunnel coincided perfectly as to alignment and grade, and daylight was visible 3 miles distant from the bottom of shaft No. 2.

The total cost of this improvement amounted to $466,753. This shows the average cost per foot for the total length of 15,494 feet to have been $30.12. During the last year of the work a total advance of 1654 feet was made, the average cost per foot for that distance being $48.82. The annual saving due to cessation of pumping amounts approximately to $164,000, at which rate the tunnel will pay for itself within 4 years. One-half of the cost of this work was paid by the Daly, whose drainage is discharged through this tunnel.

As the tunnel neared completion, it became evident that the flow of water therefrom would be permanent and of considerable amount, though no means existed by which the normal flow for the future could be accurately foretold. However, the quantity of water handled by the pumps during past years was known with reasonable accuracy, as was also the decrease in that quantity due to the approach of the face of the new drain. Measurements of the flow at the tunnel mouth had been made from time to time, and comparison of these various sets of figures gave some indication as to the future discharge, and showed that opportunity existed for securing additional conveniences and economy by utilizing the water at the tunnel mouth, where a short and steep fall was readily available.

The idea of electrically transmitting this waste energy to those distant points where it could be usefully applied was adopted by Superintendent R. C. Chambers, and the matter of designing and constructing a suitable plant was referred to the writer.

Surveys and measurements made at this time, while the tunnel was yet several hundred feet from completion, showed a steady flow of water amounting to about 800 c. f. per minute and an available fall close to the tunnel mouth of 125 ft. in 380 ft. The general opinion was that a decrease would take place in the near future, but many facts and figures convinced the engineer in charge of the work that a permanent increase would occur in the flow at the mouth. Accordingly a plant was decided upon of sufficient capacity to furnish light to all of the hoisting works, mills, and dwelling-houses belonging to the Ontario and Daly mining companies, and sufficient power during the day to drive the machine shops of the mines and mills. No underground lighting was attempted.

The choice of a route for the transmission line lay between an overhead line, following a well-traveled road through cañons for a maximum distance of about 6½ miles, and an underground line through the tunnel, to a point well adapted for a center of distribution, and offering advantages in saving of copper and ease of inspection.

The overhead route was considerably the longer, involved a somewhat wider distribution of load along the main line, and exposed the line to extremely heavy winter weather and to frequent and severe storms during summer. This route was easy of inspection throughout, except in winter weather.

The underground route presented the advantages of a shorter line, greater facilities for uniform voltage throughout the system, and absolute protection of the transmission from bad weather and lightning; the entire main line, too, could be inspected and repaired by a workman without dismounting from a tram car. On the other hand the cost of erection and danger of accidental contact were greater, and the maintenance of proper insulation of the line seemed impossible, owing to the floods of water falling from the roof and timbers of the tunnel, the frequent shifting and breaking of timbers, and the great number of insulating supports required for mechanical strength. Therefore the overland route was chosen for the transmission.

The hydraulic plant is located about 1600 ft. from the mouth of the drain tunnel. The water is conveyed through a wooden flume and ditch to a pressure tank, there being also an overflow ditch with adjustable gate for disposing of surplus water. The pressure tank is provided with a settling compartment and racks for catching drift contained in the water. From the pressure tank is led a wrought-iron pipe of varying diameter.

The prime mover is a 3-ft. Pelton tangential wheel calculated to deliver on the main belt 90 h. p. when running at 280 revolutions per minute under 120 ft. effective head.

The conditions to be fulfilled in the selection of a type of electrical equipment for this plant removed all direct current systems from consideration. The choice lay between the various alternating single and multiphase systems, generating the maximum line voltage directly, and supplying reducing transformers at various points along the main line. The Monocyclic system was adopted by reason of great simplicity of the system as a whole, its freedom from lack of balance between the different circuits, the ability to successfully operate self-starting motors of a simple and well-tried type, as well as arc and incandescent lights, and, finally, its first cost, which in this case was less than for any other system excepting the three-phase

The electrical equipment of the power house includes an eight-pole, 60-kilowatt, Monocyclic alternator, driven at 900 revolutions by a twelve-inch belt from the pulley on the wheel shaft. This dynamo at no load generates 2200 volts at 60 cycles per second, and normal excitation is supplied by an Edison bipolar shunt machine driven from the alternator shaft. The dynamo is over-compounded to furnish 2500 volts with a full load current of 25 amperes.

From the terminals of the generator three main leads are taken to a skeleton switchboard, on which are located switches, rheostats, indicators, lightning arresters, and a gage indicating the pressure of the water supplied to the wheel below. All wiring between the dynamo and switchboard is carried beneath the floor of the dynamo room on porcelain insulators in plain sight. The engineer has full control of the entire system without leaving the side of the switchboard.

The transmission line covers a total distance of 6½ miles, and traverses a very rough and broken country, rising at one point to nearly 9000 ft. above sea level. The entire line, however, was located so as to obtain good sun exposure at all times. The poles are of red pine. The loss in the transmission at full load was calculated at about 11 per cent. between the power house and the centre of distribution.

The insulation resistance of the system is remarkably high. The total number of 16-c. p. lamps connected with the system is 700, all supplied at 110 volts. The problem of securing proper distribution of light in the various mills and hoisting works was very successfully solved by a suitable arrangement of the incandescent lamps. The arc lights formerly in use were very unsatisfactory, being difficult to maintain, owing to constant exposure of their mechanism and to clouds of metallic dust and steam, and especially objectionable because of localizing the light and casting numerous dense shadows.

The wiring and fixtures in the mills are subjected to very unfavorable working conditions. The most objectionable feature is the effect of metallic dust, steam, and sulphuric acid vapors upon exposed metal surfaces, and upon the insulation of the wire. Frequent testing has failed, however, to indicate any grounds or short circuits. Hard rubber water-proof sockets are used throughout the mills, and the lights are tapped directly on the supply branches without rosettes, the branches being protected by switches and cut-outs in sheltered places.

There are three motors connected to the system, two of 15 h. p. each and one of 25 h. p. The 15-h. p. motors drive the machine shops of the Marsas Mill and the Ontario Mine; the large motor is located in the saw mill at Ontario No. 3 shaft.

On February 24, 1895, the plant was started. A trial run failed to develop any defects throughout the entire installation. On the following day, during a heavy storm of snow and sleet, the entire load of lamps connected with the system was thrown on. The performance, under load, of the installation in the power house was thoroughly satisfactory. The dynamos ran smoothly and quietly, and failed to show any evidence of heating in any part. This lack of heating has characterized their performance at all times since the beginning of operations.

The method of furnishing excitation to the generator in a plant of this character is a factor of vital importance in securing close regulation. It may be stated as a general rule that, where the normal field strength of the generators is a function of their speed, close regulation of voltage for large and rapid fluctuations of load is impossible to attain in a water-power plant.

To insure constant excitation the exciting machine should always be driven by a separate water wheel, where the conditions permit of such arrangement.

The plant has run constantly since its completion without interruption or repairs of any sort, barring the breakage of the exciter shaft by a tight belt shortly after the start. The accident caused interruption of service for 12 hours only, and was purely a result of carelessness. During the month of June some interesting experiences occurred with lightning. On one occasion an electric storm of great intensity prevailed along parts of the line most distant from the power house. During the space of a half hour no less than thirteen separate strokes of lightning came into the switchboard from the main line, all of these being successfully discharged by the arresters. The final discharge, however, was of such severity as to start an arc between the discharge points of the arresters on the two main wires. This arc of comparatively low resistance immediately short-circuited the dynamo through a portion of the large copper strip used as a ground connection, and the machine ran in that condition for fully 10 seconds before being disconnected. No damage whatever was sustained by the dynamo. The two arresters, however, were rendered absolutely useless, the brass discharge knobs being completely melted down, and several were fused together. After removing the damaged arresters, the dynamo was again started, and no further difficulty was encountered.

Two engineers are employed to operate the Ontario electric system, each of whom runs the plant 12 hours daily. No labor is involved, and, owing to the steadiness of the load both day and night, the attention required in the power house is limited to the inspection of oil in the various bearings and the starting and stopping of the plant at the beginning and end of each run, at which time the machinery is wiped off. The motors require no attention during their operation. The entire system at any instant involves only the attendance of the engineer at the power house, who also makes any slight repairs or alterations required from time to time throughout the distribution. The operating expenses therefore practically include only the engineer's pay, occasional minor supplies, and lamp renewals.

The total cost of the Ontario system is a matter of gratification when viewed in comparison with recent figures showing cost of similar installations elsewhere, and in view of the diversity of service and economy of attendance secured. The saving effected by the installation is somewhat difficult to estimate accurately because of the large additional service hitherto unpossessed by the company. The interest account is somewhat higher than that charged against the old arc light plant. The labor account for the service now rendered by the present plant is very considerably reduced, some income is already derived from the sale of current for lighting, and the amount saved annually in fuel and illuminating oil exceeds $3000.

The great drain tunnel is being extended through the Ontario ground to the Daly mines, and a continuation of work has resulted in a notable increase in the flow of water available at the power house, the amount being at present about 1500 cubic feet per minute.

Negotiations are nearly completed for doubling the installation at the power house, with the object of providing a reserve unit in case of break down, and of selling current by contract to a local organization for lighting and incidental power service in Park City.

The extension of the plant will involve but comparatively small outlay and labor, and the attendance will not be increased.

It is, therefore, confidently expected that the plant will be made to earn dividends, in addition to furnishing its present service free of cost to the owners.

THE ARCHITECTURE OF MODERN HOSPITALS.

By E. C. Gardner.

LONG, long before "man's inhumanity to man" had been recorded in modern poetry, man's love for man had borne visible fruit in the shape of hospitals and asylums. There is good reason to believe that in the vast basin of the Nile there existed medical schools and institutions thousands of years before the beginning of the Christian era. There is believed to have been a hospital in Ireland 300 years B. C., and about the same time the great king of India, Asoka, ordered hospitals to be built throughout his kingdom. A famous Chinese traveller records a few hundred years later that "the nobles and landowners of India have founded hospitals in the cities, to which the poor of all countries, the destitute, the cripples, the diseased, can repair for shelter. They receive every kind of help gratuitously. Physicians inspect their diseases, and, according to their cases, order them food and drink, decoctions and medicines,—everything, in fact, that may contribute to their ease." The oldest hospital for women is said to exist in Siam. The ancient Greeks and Romans, from whom, or through whom, may be traced most of all that is called "modern civilization," maintained dispensaries and hospitals. Charlemagne and the Moors in Spain founded hospitals more than 1000 years ago, and it is said that during the thirteenth century there were nineteen thousand hospitals, or something that stood for hospitals, in Europe. Evidently the "Dark Ages" were not all darkness. In 1456 Francesco Sforza founded the great hospital in Milan which, with over two thousand beds, is one of the largest general hospitals in the world. Many hospitals existing in England were founded in the twelfth and thirteenth centuries, and the English have been founding others and making over the old ones ever since. The great London hospital of St. Bartholomew was established early in the twelfth century, and the hospital of The Holy Spirit at Rome, which in the seventeenth century had a revenue of $200,000, was begun in 1198.

All this and much more may be found in that book of wonderful research, "Burdett's Hospitals and Asylums of the World," but it is unnecessary to give farther examples to show that hospitals are not exclusively "modern" institutions. And yet the advance in medical and surgical science that has taken place during the last half century has been so great that the hospital planning, construction, and management considered wise and satisfactory two or three generations ago would now almost be thought detrimental rather than helpful.

Until within 100 years but little was known of the importance of cleanliness in the atmospheric and visible environments of the sick and wounded, although in the fourteenth century the Italians understood something of the nature of contagion, and attempted isolation on that account. The insane were treated almost as criminals, or, at best, as if they were to be blamed rather than pitied for their infirmity. All psychological influences, now recognized as of the greatest importance, were ignored and left to accident. Surgical operations were performed in the rooms containing the sick, and ventilation was so little comprehended that even in the early part of the present century one of the English encyclopædias makes this astonishing suggestion: "When the ceilings of hospitals are low, it will be found wise to remove some part of them, to open the garret story. The doors and windows may likewise be opened. In winter the hospital wards are to be warmed with chimneys [sic] and never by stoves, for, though the latter may warm a large ward better and at less expense, yet by scarce making any draught of air they will be apt to increase its putrid quality"! And we are told that not so very much longer ago the physicians, in going their rounds among the patients, were obliged to carry scented handkerchiefs and various other refreshing stimulants to enable them to per-

CANCER HOSPITAL, NEW YORK CITY—C. C. HAIGHT, ARCHITECT.

ROOSEVELT HOSPITAL, NEW YORK CITY—R. M. HUNT, ARCHITECT.

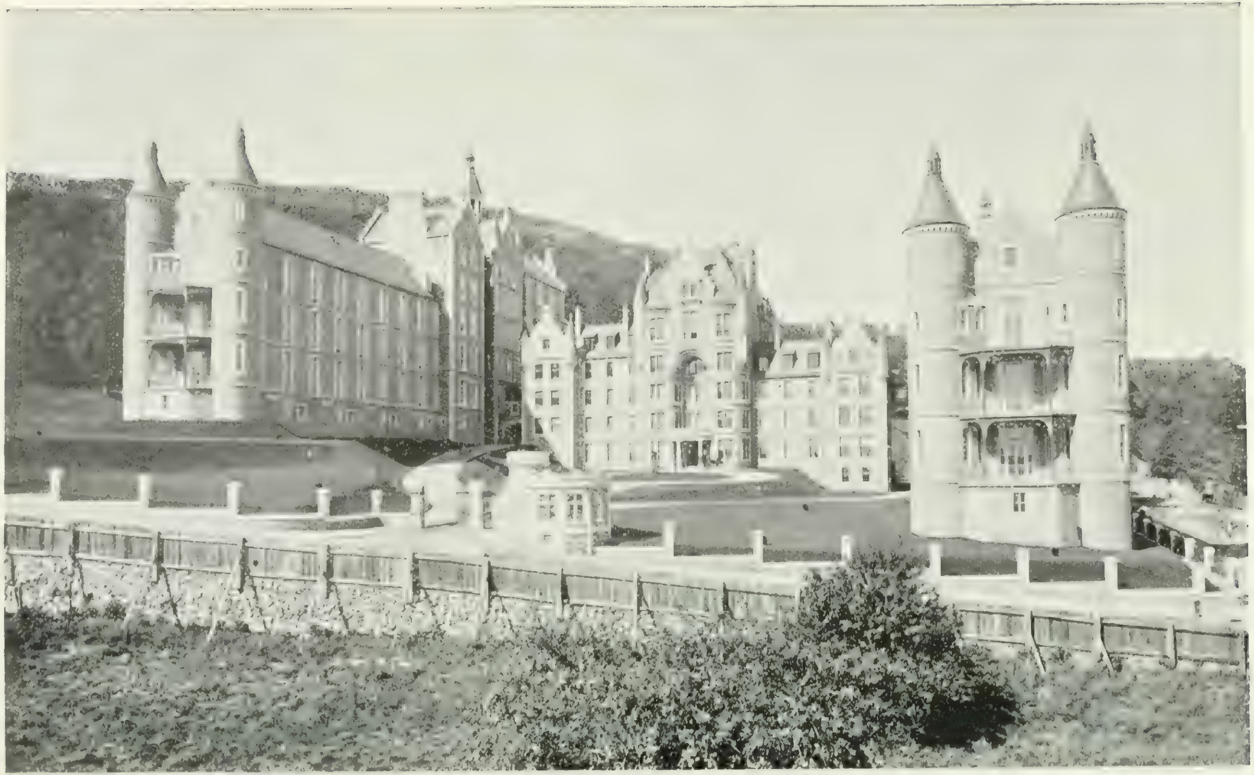
form their painful duties without nausea or faintness. Now, as Dr. Weir Mitchell has said of a patient in a modern hospital: "If that sick boy were lord of a guinea a minute, no more could be known of his case, no more could be done for him."

All of which goes to prove that the world does move, even though on the old lines laid down in the beginning. Solomon might still declare that there is no new thing under the sun; but, if our new ways of doing the old things could have been tried on in Jerusalem, they would have made the Queen of Sheba dumb with amazement.

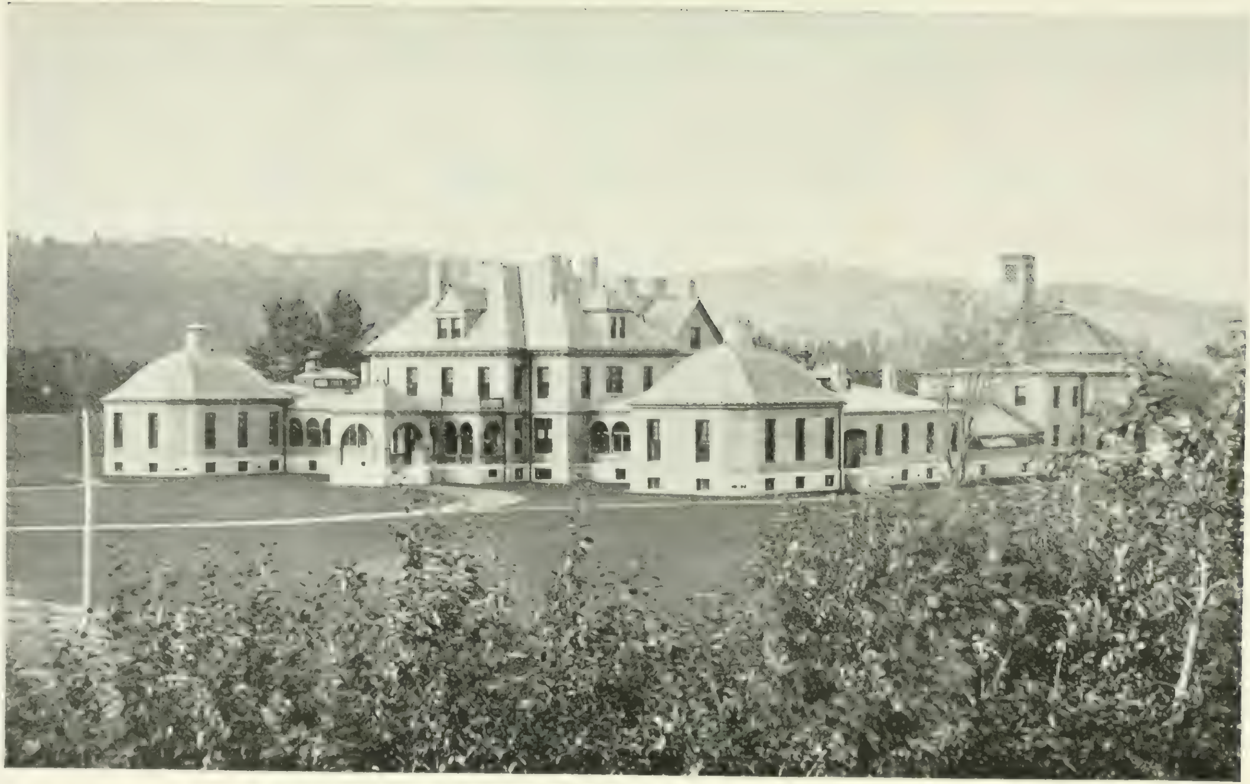
In a study of the planning and construction of hospitals the first step is to discover the ruling motive,—to answer the question, "Why?" The answer is easy. The center around which all else revolves, whether the hospital is to contain six, sixty, or six hundred patients, is the ward. This *is* the hospital. The administrative offices: the operating theaters: the heating and ventilating systems: the bath-rooms and reception-rooms: the home or training school for nurses; the store-rooms, dispensaries, kitchens, dining-rooms, and servants' quarters, whether the same be few or numerous,—all these are merely adjuncts to the ward. One perfect ward is the model for every other. It may be said almost without qualification that the one essential of the perfect ward is cleanliness; not alone the visible cleanliness that results from washing with many waters and removing conspicuous dirt, but that more essential and immeasurably more difficult cleanness which protects from the germs of disease, bacilli, effluvia, odors, and emanations of all sorts. Even the site is determined by the requirements of the ward. It must afford ample light, security against noxious elements from outside, and opportunity to be, materially speaking, in the world, but not of it.

Assuming that there are money and land enough, it is hardly necessary to say that the site for a hospital should be chosen with special regard to its sanitary character; that it should be naturally dry and easy of drainage, both on the surface and underground; that it should have the most favorable outlooks, and be sheltered from the winds. It should likewise be of such extent that the noise and dust of crowded thoroughfares will not reach it,—a condition that will also allow the buildings to be placed with little or no regard to the "street front." As for shade trees, with all their beauty and charm, and their grateful effect, real and apparent, upon the summer air, it is rarely wise to choose a lot on account of the trees growing upon it. Compared with the life of the hospital, the tree is but a temporary affair, and there is no more common mistake than misplacing a build-

ADMINISTRATION BUILDING, JOHNS HOPKINS HOSPITAL, BALTIMORE, MD.



ROYAL VICTORIA HOSPITAL, MONTREAL.

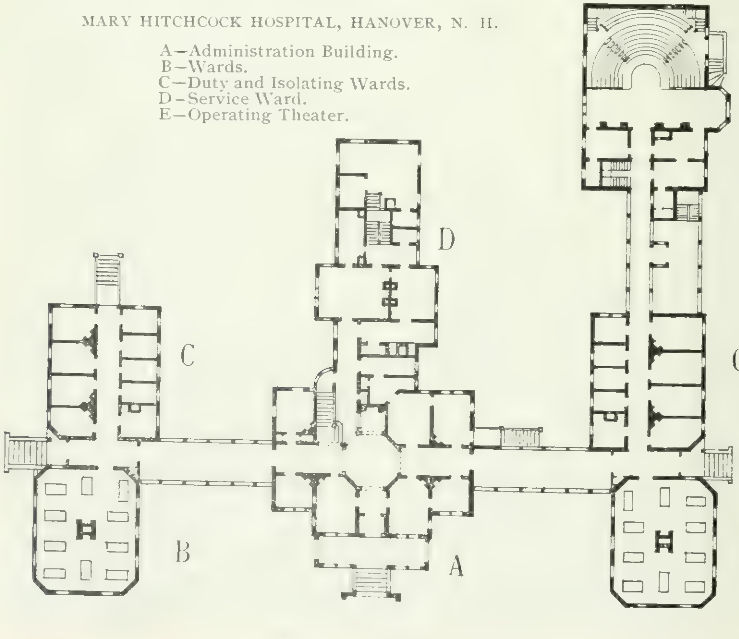


MARY HITCHCOCK HOSPITAL, HANOVER, N. H.—RAND & TAYLOR, ARCHITECTS.

ing for the sake of sparing a tree that may be struck by lightning or palsy before the building is finished. It should also be remembered that 5 years—at the outside 10—will afford all the shade, all the verdant background, and all the shelter from pitiless winds that are necessary either for utilitarian or esthetic purposes. It sometimes happens that a natural slope in the surface of the ground may be employed in such a way as to seem to add to the excellence of the site. But this again, beyond what will ensure good surface drainage, is of little real importance, because, if a varying surface will allow a better adjustment of the floors, it can be easily obtained by grading.

It has been found in large cities that there is a marked increase of epidemic and contagious diseases in the immediate vicinity of hospitals where such diseases are treated, and this fact, with other considerations, has led to the building of new hospitals farther and farther from the centers of dense population, the great improvement in ambulances making the transportation of patients less difficult.

In some of the large cities of Europe it has been thought wise to go several miles towards, if not actually into, the open country. To diminish, if not actually remove, this danger of contagion, the expedient has been recently adopted in England of forcing the expelled impure air from the contagious wards through a chamber heated to



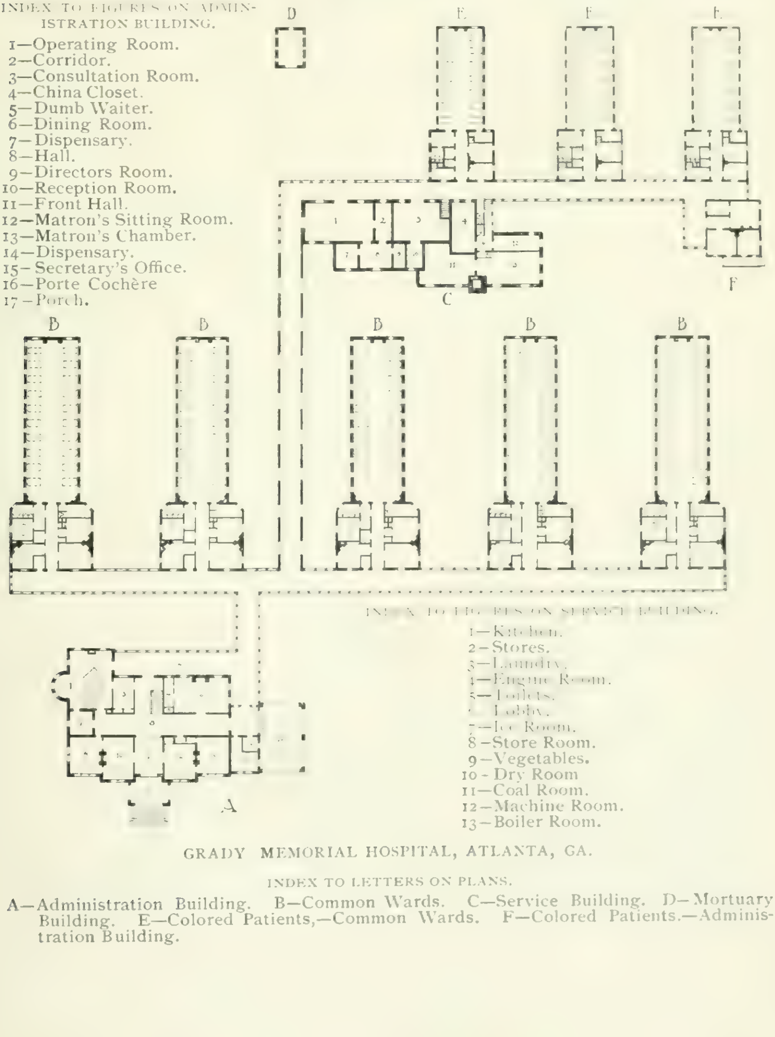
MARY HITCHCOCK HOSPITAL, HANOVER, N. H.

A—Administration Building.
B—Wards.
C—Duty and Isolating Wards.
D—Service Ward.
E—Operating Theater.

such a degree that all dangerous germs are destroyed. But this concerns ventilation and opens interesting speculations in other ways. We wonder whether the time will come when we shall see traps for dangerous microbes as we now do for mice, woodchucks, and bears.

Whether the plan determines the site or the site the plan, their intimate relation cannot be ignored, for, however uniform the needs may be, there is infinite variety in the details of their adjustment, and it would be practically impossible to find two sites so nearly alike that a plan adapted to one would, without modification, suit the other.

What is known as the pavilion plan is at present preferred for general hospitals. This means that each ward is wholly or partially


INDEX TO FIGURES ON ADMINISTRATION BUILDING.

1—Operating Room.
2—Corridor.
3—Consultation Room.
4—China Closet.
5—Dumb Waiter.
6—Dining Room.
7—Dispensary.
8—Hall.
9—Directors Room.
10—Reception Room.
11—Front Hall.
12—Matron's Sitting Room.
13—Matron's Chamber.
14—Dispensary.
15—Secretary's Office.
16—Porte Cochère
17—Porch.

INDEX TO FIGURES ON SERVICE BUILDING.

1—Kitchen.
2—Stores.
3—Laundry.
4—Engine Room.
5—Toilets.
6—Lobby.
7—Ice Room.
8—Store Room.
9—Vegetables.
10 - Dry Room
11—Coal Room.
12—Machine Room.
13—Boiler Room.

GRADY MEMORIAL HOSPITAL, ATLANTA, GA.

INDEX TO LETTERS ON PLANS.

A—Administration Building. B—Common Wards. C—Service Building. D—Mortuary Building. E—Colored Patients,—Common Wards. F—Colored Patients.—Administration Building.

A—MEN'S WARDS.

1—Drying Room.
2—Nurse (Isolating Ward).
3—Toilet (Nurse).
4—Bath (Medical Ward).
5—Medical Ward.
6—Sun Room.
7—Nurse (Medical Ward).
8—Toilet.
9—Toilet.
10—Nurse (Surgical Ward).
11—Bath (Surgical Ward).
12—Tea Kitchen.
13—Linen Closet.
14—Surgical Ward.
15—Sun Room.

B—ISOLATING WARD (MEN).

C—ADMINISTRATION BUILDING.

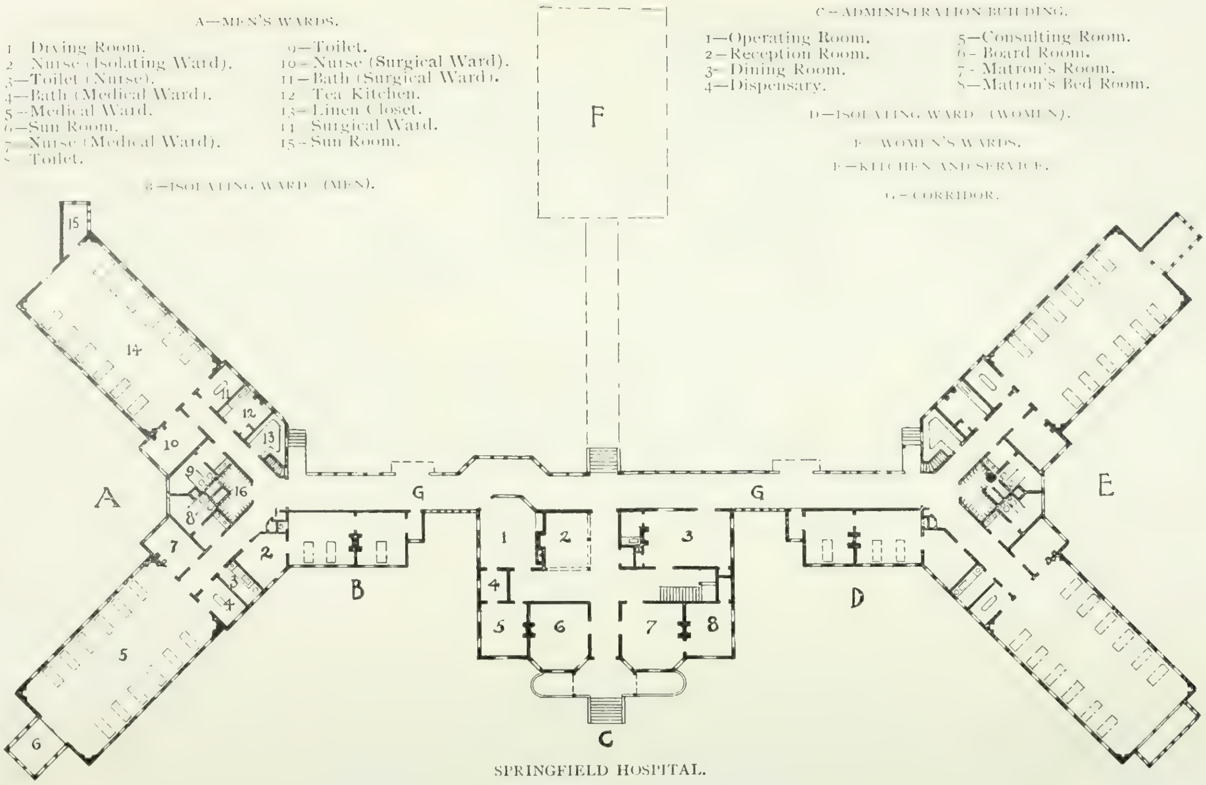
1—Operating Room.
2—Reception Room.
3—Dining Room.
4—Dispensary.
5—Consulting Room.
6—Board Room.
7—Matron's Room.
8—Matron's Bed Room.

D—ISOLATING WARD (WOMEN).

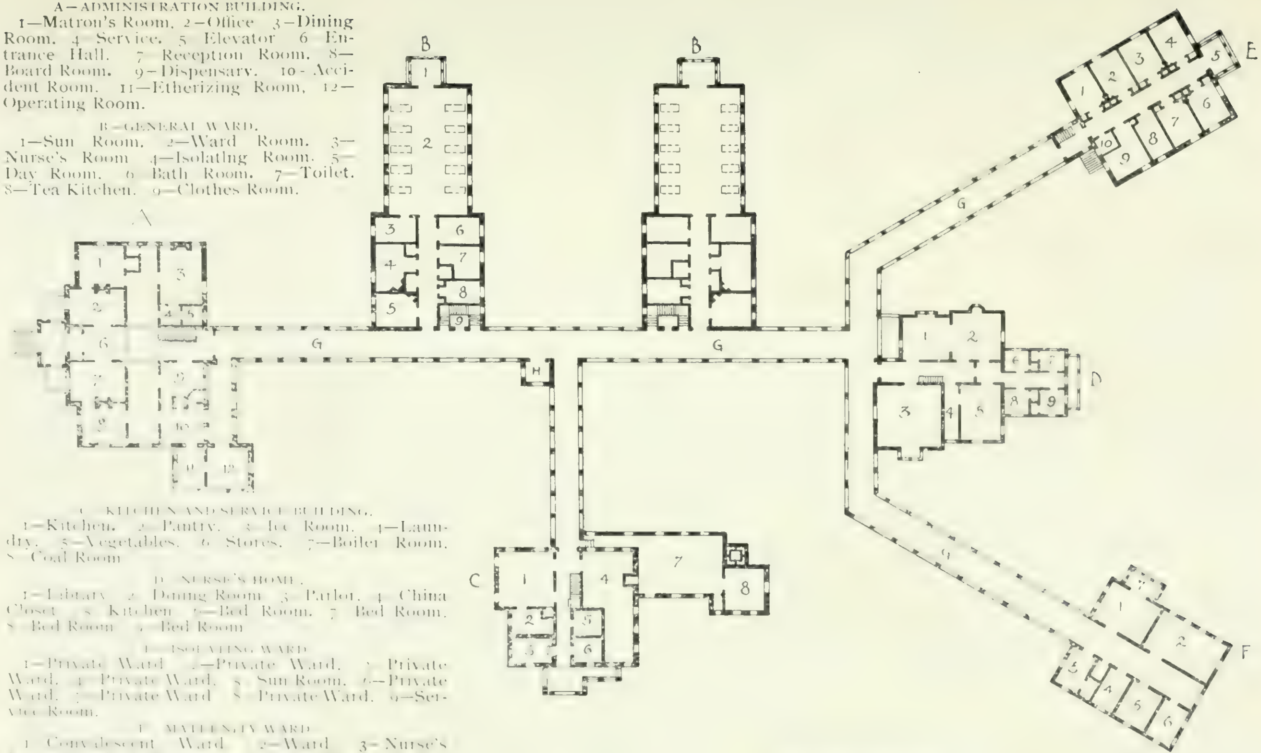
E—WOMEN'S WARDS.

F—KITCHEN AND SERVICE.

G—CORRIDOR.



SPRINGFIELD HOSPITAL.



A—ADMINISTRATION BUILDING.

1—Matron's Room. 2—Office. 3—Dining Room. 4—Service. 5—Elevator. 6—Entrance Hall. 7—Reception Room. 8—Board Room. 9—Dispensary. 10—Accident Room. 11—Etherizing Room. 12—Operating Room.

B—GENERAL WARD.

1—Sun Room. 2—Ward Room. 3—Nurse's Room. 4—Isolating Room. 5—Day Room. 6—Bath Room. 7—Toilet. 8—Tea Kitchen. 9—Clothes Room.

C—KITCHEN AND SERVICE BUILDING.

1—Kitchen. 2—Pantry. 3—Ice Room. 4—Laundry. 5—Vegetables. 6—Stores. 7—Boiler Room. 8—Coal Room.

D—NURSE'S HOME.

1—Library. 2—Dining Room. 3—Parlor. 4—China Closet. 5—Kitchen. 6—Bed Room. 7—Bed Room. 8—Bed Room. 9—Bed Room.

E—ISOLATING WARD.

1—Private Ward. 2—Private Ward. 3—Private Ward. 4—Private Ward. 5—Sun Room. 6—Private Ward. 7—Private Ward. 8—Private Ward. 9—Service Room.

F—MATERNITY WARD.

1—Convalescent Ward. 2—Ward. 3—Nurse's Room. 4—Bath Room. 5—Private Ward. 6—Private Ward.

G—CORRIDOR. H—ELEVATOR.

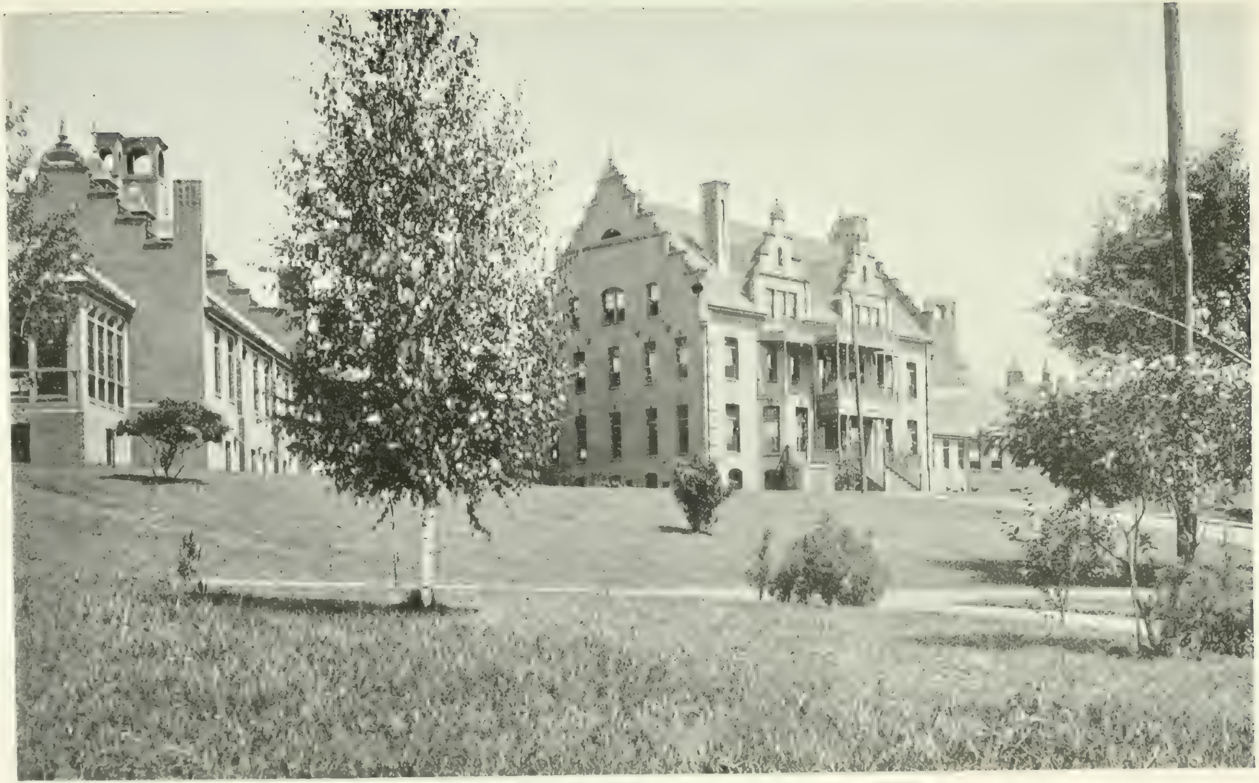
BACKUS HOSPITAL.

detached from every other, either in separate buildings or by means of semi-detached wings. In brief, there are two essential points to be gained: the fullest measure of convenience in passing from one ward to another, or from the administrative offices to the wards; and the desired isolation.

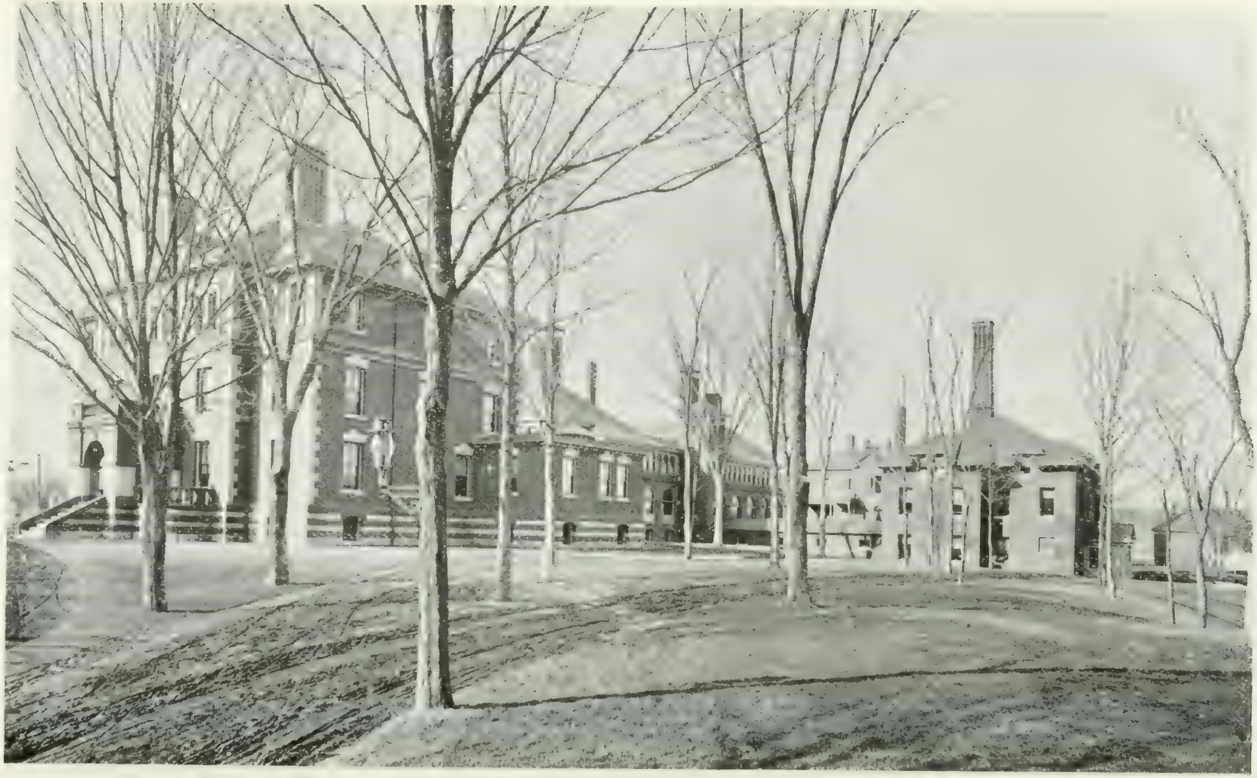
As a loss in one direction is a gain in the other, the adjustment of these two requirements varies according to circumstances. For instance: wards for contagious diseases of the milder types would demand greater sacrifices in the way of accessibility than would be desirable where the only need of isolation is to diminish as far as possible the objectionable consequences of assembling large numbers of sick or wounded people in close proximity. On the other hand, for actively contagious diseases more complete isolation must be secured at whatever sacrifice of convenient approach. When all has been done for cleanliness that can be done in the choice of the site, it remains to consider the building itself. In order to lay a broad foundation for perfect cleanliness, two things are needful,—simplicity and honesty.

It is probable that most of the hospitals that have been built in this country during the present century could be burned without any difficulty, and that most of those to be built in the next 25 years will also be contrived with reference to prompt and easy combustion if they should happen to take fire. And yet, unless distinctly intended to be destroyed, for sanitary reasons, as often as every 5 years, a hospital ought to be fire-proof,—not merely slow-burning, but proof against destruction by fire,—because of the helplessness of the occupants in case of fire, because it is easier to give to fire proof structures the qualities of cleanliness, immunity from constant repairs, and protection against noise, and because fire-proof means time-proof. It is one of the anomalies of our progressive age that so little is done to render all important buildings—public, commercial, and domestic—safe as well as durable.

"Fire-proof" means walls of masonry and floors and roofs of masonry or iron and masonry combined. It means that all flues for ventilation and warming are of the same incombustible materials; it allows, if it does not positively require, the wood used in the interior fittings to be reduced to the minimum. The outer wall will be double with a well-ventilated air space between the two shells of not less than 1½ in. The inner surface will be smoothly finished with cement, painted and varnished, and thus made practically impervious to moisture and dust. Something better than this may be devised, but, up to date, nothing seems safer, cleaner, and more durable. All sorts of tiles and glazed bricks have more or less cracks, and I am not aware that any so-called "glass" finish has been devised that is not liable to the same



CITY HOSPITAL, SPRINGFIELD, MASS.—E. C. GARDNER, ARCHITECT.



BACKUS HOSPITAL, NORWICH, CONN.—GARDNER, PYNE & GARDNER, ARCHITECTS.

GRADY HOSPITAL, ATLANTA, GA.

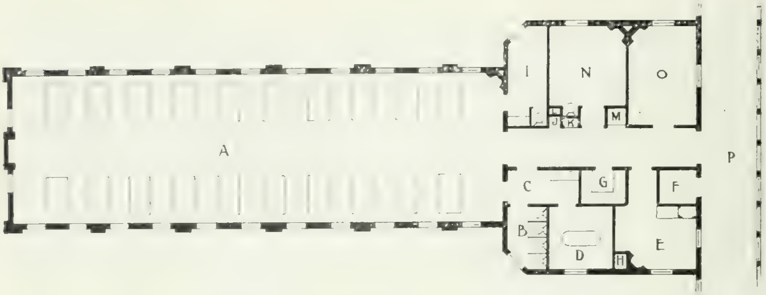
CIVIL HOSPITAL, VENICE.

fault. It is true that oil paint and the most durable varnishes available for this purpose are not absolutely impervious to hot soap suds and indiscriminate scrubbing, but there need be no indiscriminate scrubbing in a common ward, while the paint and varnish are easily renewed. Around the door and window openings there is no occasion for wood finish, or for stucco, cement, or marble "trim." Everything of that sort provides either fine cracks between the wood (or other material) and the surface on which it rests, or certain projections and hollows which afford resting-places for dust and whatever dust harbors. There will be no sharp angles to be abraded or filled with dirt, and, where the vertical walls join the floors, there will be a sufficient curve, either in the material of the floor or that of the wall, to allow easy and perfect cleaning. The ceiling will be treated like the walls in every respect except color. In brief, the inside of the ward will be as nearly as possible like a perfectly clean, smooth box, in which there are no rough places for dust to gather around and microbes to build their nests upon, no part which may not be reached by a damp sponge, and none which may not be kept so clean that it would not soil the finger-tip of a white kid glove.

As every housekeeper knows, the part of the house most difficult to keep clean is the floor. In a hospital carpets would be absurd;

INTERIOR COURT, HOSPITAL OF THE INNOCENTS, FLORENCE, ITALY.

at the best they merely retain, and for a time conceal, the dirt that is sure to be present in them. Wooden floors made in the ordinary way have cracks especially contrived as fertile fields for the cultivation of microbes. Cement, even of the hardest, wears and produces a dust, all the more detrimental by reason of its fineness, and marble or burned tiles have both the dust and cracks against them, besides being hard and cold. Some durable, clean, elastic material of good color may yet be invented, but at present hard, fine-grained wood in the

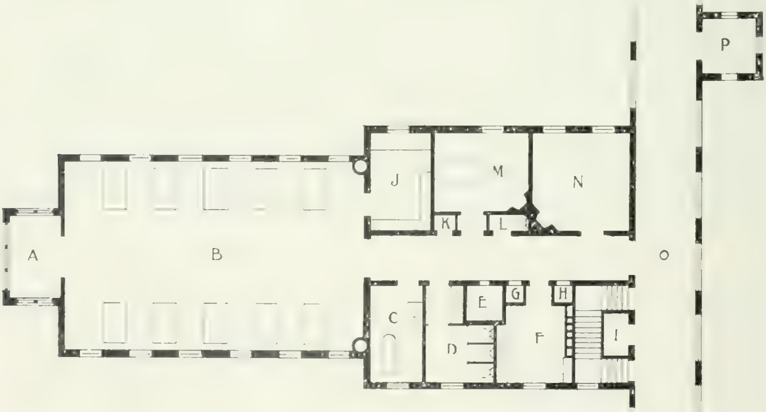


WARD BUILDING, GRADY HOSPITAL.

A—General Ward. B—Sanitaries. C—Toilet. D—Bath Room. E—Kitchen. F—Clothes Room. G—Linen Room. H—Vent. I—Nurse's Room. J—Stool Closet. K—Dry Room. L—Vent Shaft. M—Clothes Chute. N—Isolating Room. O—Dining Room. P—Corridor.

form of parquetry, or laid in such manner that there will be no cracks even after the lapse of years, appears to be the best thing for floors. A floor of this kind may be filled and coated in a way to make it practically impervious to dust and air, and, while not indestructible, it is subject only to light wear in the wards, and the coating of varnish or other protective is easily renewed. It has also the advantage of being a slow conductor of heat.

When all this is done, we have not achieved permanent cleanliness, but only provided the conditions that make visible cleanliness possible. Beyond that is the vastly more important demand for atmospheric purity. This requires the exclusion of dust from the outside,—the dust which so rapidly filters through common masonry, which

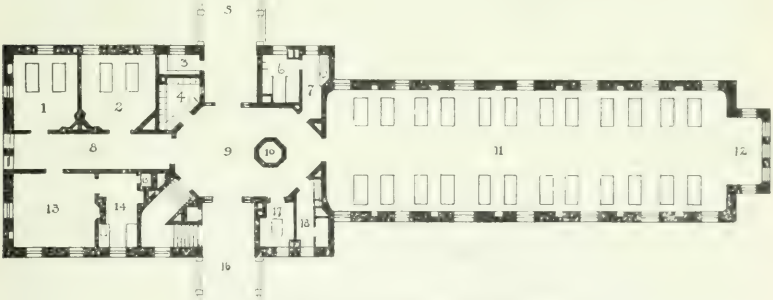


WARD BUILDING, BACKUS HOSPITAL.

A—Sun Room. B—General Ward. C—Bath Room. D—Toilet. E—Vent Shaft. F—Tea Kitchen. G—Dumb Waiter. H—Dumb Waiter. I—Clothes Room. J—Nurse's Service Room. K—Stool Closet. L—Water Closet. M—Isolating Room. N—Day Room. O—Corridor. P—Elevator.

laughs at lath and plaster walls and ceilings, and which rises through the cracks in the floors and crawls in around the window sashes. These are the foes from without. Those from within are the effluvia exhaled from the occupants, the impalpable dust that wears from clothing, bedding, and furniture, and the more evident sort that will still accompany footsteps, however well shod and shaken the feet may be that make them. Against the invisible dirt there is no protection but atmospheric washing,—that is, ventilation. Since all these impurities are constantly floating in the air, it follows that, if the air can be constantly expelled, these troublesome elements will also be cast out. And this opens the great question of pure air, and how to get it.

In practice outside air is supposed to be pure air, but this is only partially true; while artificial means may be employed for its purification, the obvious means of security against miasmatic or other prevalent atmospheric evils is the selection of a site naturally salubrious.

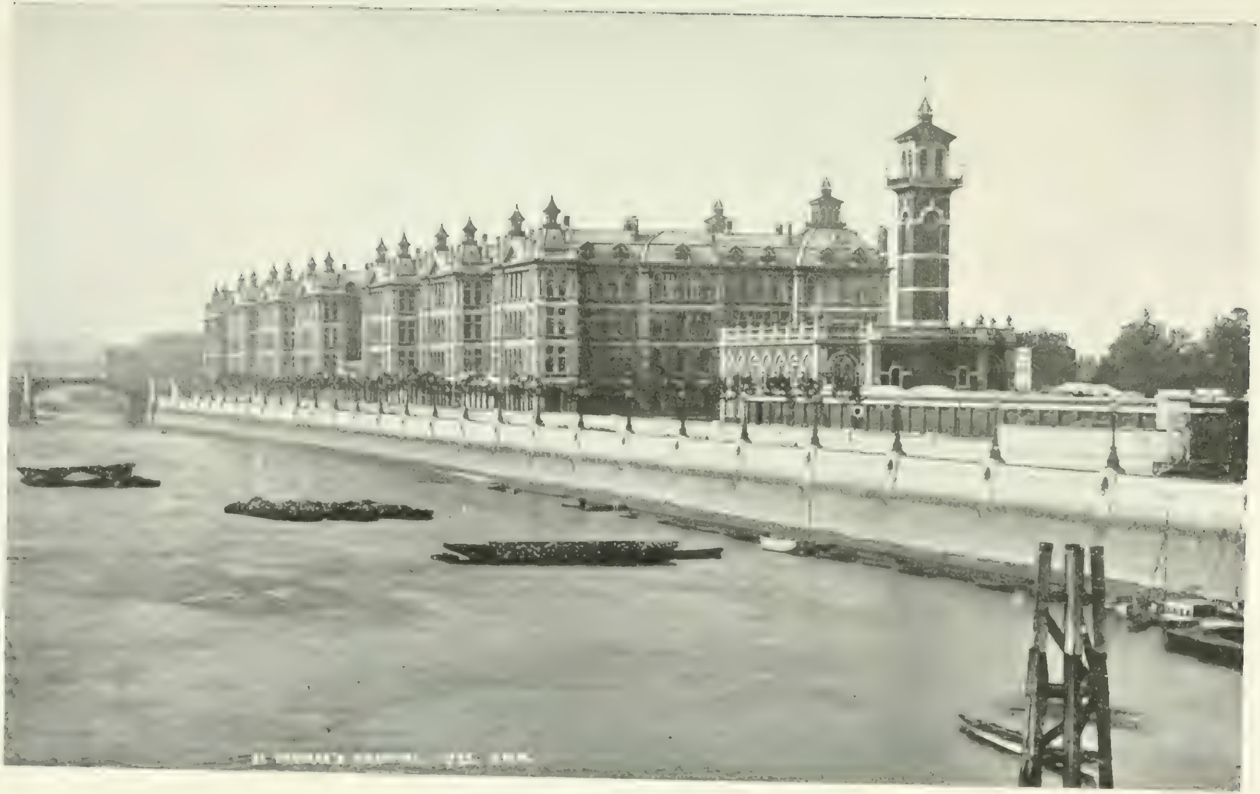


WARD BUILDING, JOHNS HOPKINS HOSPITAL.

1—Private Ward. 2—Private Ward. 3—Linen. 4—Patients' Clothes. 5—Connecting Corridor. 6—Water Closet. 7—Lavatory. 8—Corridor. 9—Central Hall. 10—Ventilating Chimney. 11—Ward. 12—Sun Room. 13—Dining Room. 14—Kitchen. 15—Lift. 16—Connecting Corridor. 17—Bath Room. 18—Nurse's Toilet.

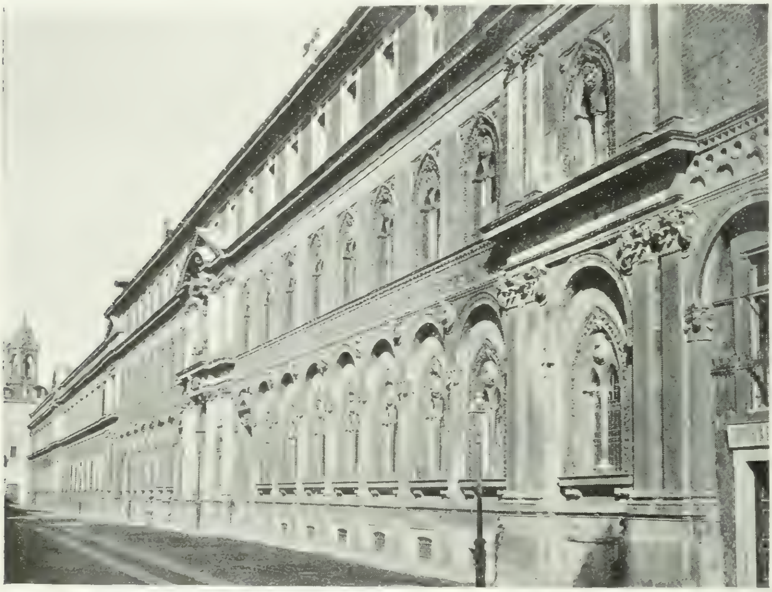
From the no-ventilation of the old hospitals where the air of the wards was so foul that even the well visitors were made sick by it, and the crude methods employed a few years ago, to the elaborate systems of fans for forcing in the air and fans for pulling it out; from the fitful drafts of wind to the flow of air automatically regulated; from the hot "chimneys" and stoves that were universal a few years ago to the steam and hot-water pipes that create an internal climate almost unvarying and quite artificial,—there is a distance as great as that between a log-cabin and a Queen Anne "villa." There have been volumes written on the subject of ventilation,—an operation whose rule can be summed up in less than a dozen words: drive out the foul, bring in the pure. One would think a mere child in invention could do that. But air, like other invisible elements, is not easily controlled; it can-

GREENWICH HOSPITAL, LONDON.



ST. THOMAS'S HOSPITAL, LONDON.

not be pulled, and it is most erratic when pushed. Consequently there are multitudes of people who are convinced that the chief advantage in the complex, expensive, and usually patented "systems" accrues to their manufacturers, and that the good old way of opening the windows when the wind blows and trusting to providence and the doctors when it does not is, after all, the safest and best. On the other hand, we are seriously advised to choose a "system" of heating and ventilating, have the plans for the same prepared, and then make the building fit the system. And yet the thing to be done seems so simple! Drive out the foul; bring in the clean. But at the very outset we strike one of the problems that have confounded the universe from the beginning. If the good and the bad would only consent to be separated, it would be easy to strangle the one and cultivate the other. But nothing has yet been discovered that would eliminate and remove atmospheric impurities. It is a case of one out, all out; not even the family of Noah can be spared by the sweeping flood that purifies the ward.



FACADE OF OSPEDALE MAGGIORE, MILAN, ITALY.

Perhaps the most common popular fallacy regarding provision for ventilation is the notion that a sufficient outlet for air is the only thing necessary, which is much as if we should expect an open door for the escape of burglars to be an adequate protection against robbery. Bad air, like untrained boys, will go where it ought, if the way of duty happens to be the easiest and pleasantest; otherwise, it will go where it ought not. For the necessary atmospheric washing, then, it appears that a certain amount of fresh air must be driven into the wards,—good authorities say 1 cu. ft. per second for each occupant,—and the same amount, of course, expelled. To secure at the same time sufficient warmth for the comfort of the patients, the incoming air must be warmed, or cooled, as the case may be, before it is brought in. Whether the chamber in which the air is warmed shall be placed under the ward, or at some distance from it; whether a single large chamber or several small ones shall be employed; whether the requisite amount of heat shall be secured by the direct combustion of the fuel, by steam, by hot water, or by electricity,—are questions which will be answered according to varying conditions. The principle is the same, however it may be carried out; air artificially warmed, and compelled to go where it is wanted. Just where this shall be introduced is, I believe, still an open question. Air expelled from the lungs, which is by no means the least cause of atmospheric impurity, undoubtedly rises immediately after expulsion. Consequently the fresh air that is expected to wash out the impurities, if brought in above the heads of the occupants while the outlets are near the floor, must take this freshly expired and unclean air and carry it down again. In the wards of the Johns

COURTYARD OF OSPEDALE MAGGIORE, MILAN, ITALY.

Hopkins hospital the inlets are near the level of the window sills, between 2 and 3 ft. from the floor, with outlets both at the floor and in the ceilings, the latter not being always open. In Massachusetts it is the practice in school rooms to admit the fresh air at a considerable height from the floor, the exhausts being at the floor. There is necessarily a loss of heat when warm fresh air is admitted at the bottom of the room and allowed to escape through the top with its double burden of dangerous impurities and precious warmth. I doubt if it has been demonstrated beyond question that a given amount of fuel will not secure as much purity and warmth in the atmosphere of a room with the so-called automatic ventilation as when the physical laws that regulate the movements of air and the diffusion of gases are opposed, which is the case when warm air is forced to come down, against its natural tendency to rise, and when it will perhaps form currents where an imperceptible flow is essential. The Spanish proverb that a scolding wife and a down draft are the two great evils of existence is generally accepted by civilized people the world over.

After the ward, its necessary adjuncts are to be considered. As Mr. Dick advised concerning David Copperfield, so the first thing to be done for a hospital patient is usually to wash him. This and other needs being constant, the bath-rooms, lavatories, and water-closets must be so near that the patients who can leave their beds at all can reach them with the least possible trouble. Then there is the "sun room," where they may be subject to that benign influence for which there is no artificial substitute,—the light and warmth of the sun's rays. Obviously, in the northern hemisphere this must look towards the south, and, as soon as a study of floor-plans is made, it will appear that the best form for a single ward of twelve or more beds is, as a rule, an elongated parallelogram. It will also appear that the most convenient place for the sun room is at one end. Obviously this requires that the long axis of the ward shall be on the meridian line, which is well for other reasons. Even sick folks must eat, and the tea kitchen for supplying this need must be as near as possible. There are also various things necessary for their comfort and proper treatment,—medicines, bandages, bedding, towels, basins, and many other appliances and implements which must always be within easy reach. All of these things necessitate a group of small rooms and closets, which together constitute a "duty ward." This general arrangement for hospital wards was not reached until after the most careful study. Those nineteen thousand hospitals of medieval Europe never dreamed of such conveniences.

Perhaps the most careful and original study at any one time, the results of which have been most generally approved by farther study and experience, has been that of Dr. John S. Billings and his associates, in the conception and execution of the plans for the Johns Hopkins hospital at Baltimore. A long room, wide enough for two rows of beds, each with its head near the outer walls and having a window at either side ; sufficient floor area and height of walls to give each patient from 1200 to 1400 cu. ft. of space ; every bed easily overlooked and approached by the nurse in charge ; sunlight from morning till night : the essential offices and appliances as near to the ward as possible without obstructing light and air.

There are still other requirements, whether the hospital is large or small. For those who are suffering from accident or other causes demanding skilful surgery, there must be an operating theater, with its special arrangements and furnishings. There must be rooms for the nurses, not adjacent to the ward, but, on the contrary, remote from it. When on duty, their place is not beside the ward, but in it. There must be a roomwhere applicants for admission to the hospital can be received and examined, and rooms for the administrative officers, the superintendent, and perhaps the resident physician. All of these adjuncts and accessories may and ought to be separate from the ward, but the separation may be by distance or by barriers of masonry. The more numerous the patients, the more numerous and spacious will be the various administrative offices.

At the least, the administrative building, or department, should provide a reception and examination room ; a room for the superintendent ; a dining-room for the nurses and officers ; an operating room ; a kitchen and laundry ; store-rooms for food and other supplies ; a dispensary ; and bed-rooms for as many nurses and servants as may be needed. The extent and arrangement of all these will depend primarily on the number of patients. Large hospitals may furnish suites of rooms for physicians, numerous consultation and examination rooms, medical library, and rooms for visitors and trustees and directors. There would be an operating amphitheater with seats for students, a home and a training school for nurses, a pathological laboratory, diet kitchen, accommodations for "out-patients," etc.

A large general hospital will have separate wards for diseases requiring special treatment. Each of the numerous contagious diseases may have its own ward, and the list seems to be constantly extending. With the evolution of the "germ theory" the value of isolation becomes more and more apparent.

It would be impracticable in a single article to give detailed description of the various equipments of the duty ward : the linen closets ; the fittings for the patients' clothes-rooms ; the drying closet ; the stool-closet ; the disinfecting chambers for bedding and clothing ;

the lifts for food, supplies, fuel, and implements. In all these there must be the same regard for durability, the same provision against dirt, decay, and combustion.

The floors of the duty ward, of the corridors, and, in fact, of nearly all the administrative offices, except the bed-rooms, should be of the most durable cement or tiles. Perhaps nothing is better than a pavement of "mischiati,"—small blocks of marble bedded in cement. The walls and ceiling of the operating theater may be lined with marble or large sheets of glass, which will allow the most thorough, frequent, and forcible cleaning. As a matter of fact the floor is the critical point, but for convenience in cleaning the floor the walls may also be unassailable.

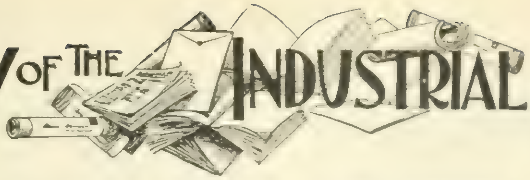
Speaking in a general way, as regards plan and construction the contagious wards should be treated like the common wards. For special wards—ophthalmic, paralytic, maternity, and others—modifications of the plan are necessary. Children's wards, among other things, should have special regard to the cheerfulness of the outlook and the concealment, as far as possible, of the inevitably depressing accompaniments of sickness. It is hardly necessary to suggest that the operating theater should have ample ceiling as well as side light, and that an etherizing, a recovery, and a surgeon's room belong to this family. The mortuary and post-mortem building will naturally be detached from all others. The kitchen, laundry, and heating arrangements, including the storage of fuel and any machinery, constitute another family, and should be in close proximity to each other, if not in a building by themselves. The general service should be completely separated from the strictly hospital work.

No reference has been made to the "pay" wards, which are essential to every complete hospital. In fact, to these the steady improvement in hospitals may be attributed.

The training-school for nurses, which could hardly exist without the hospital, promises to effect a universal reform in the care of the sick, wherever they may be. Beyond the influences which those "ministering angels" exert upon the patients in their immediate charge, they become incidental, but none the less effectual, instructors in the private homes where they are professionally employed.

In all respects these beneficent institutions are in harmony with the spirit of the age. I wish there were more space for a plea for their visible beauty, but it is always true that the architectural road to the Palace Beautiful is through the iron gate of Utility; that the noblest architecture is the simple, direct, and faithful expression of a well-understood and beneficent purpose.

REVIEW OF THE INDUSTRIAL PRESS



WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES, GREAT BRITAIN AND THE BRITISH COLONIES.

INTRODUCTORY.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance ; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

We hold ourselves ready to supply—usually by return mail—the full text of every article reviewed or indexed, and our charge in each case is regulated closely by the cost of a single copy of the journal from which the article is taken.

☞ The price of a single article is ordinarily 15c. ; those indicated by an asterisk (*) 30c. ; by a dagger (†) 45c. ; and above this, the price is given just after the number. In ordering from us care should be taken to *give the number* of the article desired, not the title alone.

The entire Review is conveniently classified into the recognized divisions of applied science—everything pertaining to "Architecture and Building" appearing under that heading, while "Civil Engineering" is given under that title, and so on alphabetically throughout. The titles and addresses of the majority of the journals reviewed are given below. Serials are usually indexed only on the appearance of the first installment; the original notice may be found by consulting previous lists. Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell coupons—represented here in miniature.

The price of these coupons is 15c. each, or fifteen for $2, forty for $5, and one hundred for $12.

This Coupon will be received by us in payment for any 15 cent article catalogued in The Technical Index of the ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be required for each 15 cents; thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on.

Engineering Magazine Co., *New York:*

Please send Article No ______________ *to the following address.* ______________________

Simply fill in the number, and your address. A stamped envelope does the rest. No letter-writing is required.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their great convenience and economy.

THE PUBLICATIONS REGULARLY REVIEWED.

Age of Steel. *w.* $3. St. Louis.
American Analyst. *f.* $1. New York.
American Architect. *w.* $6. Boston.
Am. Chem. Journal. *b-m.* $4. Baltimore.
Am. Eng. and Railroad Journal. *m.* $3. N.Y.
Am. Gas Light Journal. *w.* $3. New York.
Am. Geologist. *m.* $3.50. Minneapolis.
Am. Jour. of Science. *m.* $6. New Haven.
American Machinist. *w.* $3. New York.
Amer. Mag. of Civics. *m.* $3. New York.
Am. Man. and Iron World. $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. N. Y.
Amer. Soc. of Irri. Eng. *qr.* $4. Denver.
Am. Soc. of Mec. Eng. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Archæologist, The. *m.* $1. Columbus, O.
Architect, The. *w.* 26*s.* London.
Arch., Build. and Dec. *m.* $2. Minneapolis.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. N. Y.
Arena. *m.* $5. Boston.
Aust. Mining Standard. *w.* 30*s.* Sydney.
Banker's Mag. *m.* 18*s.* London.
Bankers Mag. of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Boston Jour. of Commerce. *w.* $3. Boston.
Brick Builder. *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bul. Am. Geog. Soc. *q.* $5. N. Y.
Bul. Am. Iron and St. Asso. *w.* $4. Phila.
Bul. of the Univ. of Wisconsin.
Calif. Architect. *m.* $3. San Francisco
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Rev. *m.* $1.50. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan. *m.* $2. Meadville, Pa.
Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
Colliery Engineer. *m.* $2. Scranton, Pa
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Contemporary Review. *m.* $4.50. London.
Cosmopolitan. *m.* $1.50. New York
Domestic Engineering. *m.* $2. Chicago
Electric Power. *m.* $2. N. Y.
Electric Railway Gazette. *w.* $3. N. Y.
Electrical Age. *w.* $3. New York.
Electrical Engineer. *w.* 19*s.* 6*d.* London.

Electrical Engineer. *w.* $3. New York.
Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Journal. San Fancisco.
Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer. *s-m.* $2.50. New York.
Engineer. *w.* 36*s.* London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineering. *w.* 36*s.* London.
Eng. and Mining Journal. *w.* $5. N. Y
Engineering Magazine. *m.* $3. New York
Engineering Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. So. of W. Pa. Proc *m.* $7. Pittsburg.
Fairplay. *w.* 32*s.* 6*d.* London.
Fire and Water. *w.* $3. New York.
Fortnightly Review. *m.* $4.50. London.
Forum. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World. *w.* 13*s.* London.
Geol. Mag., The. *m.* 18*s.* London.
Heating and Ventilation. *m.* $1. N. Y.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Industry. *m.* $2. San Francisco.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age. *w.* $4.50. New York.
Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
Iron & Steel Trades' Jour. *w.* 25*s.* London.
Iron Ind. Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Chem. So. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Jour. Assoc. Eng. Soc. *m.* $3. St. Louis.
Jour. Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. As. *q.* $2. New London.
Jour. Polit. Economy. *q.* $3. Chicago.
Jour. of Royal Inst. of Brit. Arch. *s-q.* 6*s.* London.
Journal of the So. of Arts. *w.* London.
Locomotive Engineering. *m.* $2. N. Y.
Lord's Magazine. *m.* $1. Boston.
Machinery. *m.* 50 cts. N. Y.
Machinery. *m.* 9*s.* London.
Manufacturer and Builder. *m.* $1.50. N. Y.
Manufacturer's Record. *w.* $4. Baltimore
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Mag. *m.* $1. N. Y
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. N. Y.
Milling. *m.* $2. Chicago.
Min. and Sci. Press. *w.* $3. San Francisco.
Mining Industry. *w.* $3. Denver.
Mining Jour, The. *w.* £1. 8*s.* London.
Mining Review, The. *w.* $2. Denver.
Mining World, The. *w.* 21*s.* London.
National Builder. *m.* $3. Chicago.
National Car Builder. *m.* $2. New York.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. N. Y.
Nineteenth Century. *m.* $4.50. London.
North American Review. *m.* $5. N. Y.
Paving & Mun. Eng. *m.* $2. Indianapolis.
Plumber and Decor. *m.* 6*s.* 6*d.* London.
Popular Science Monthly. *m.* $5. N. Y.
Power. *m.* $1. N. Y.
Practical Engineer. *w.* 10*s.* London.
Procd. Engineer's Club. *q.* $2. Phila.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. N. Y.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway Times, The. £1. 5*s.* London.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Rhodes' Jour of Banking. *m.* $5. N. Y.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. N. Y.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. N. Y.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y
Social Economist. *m.* $2. N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
St. R'y. Elec. News. *m.* $2. Minneapolis
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn.
Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. N. Y.
Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
Trans. of the Wis. Acad. Madison.
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.

ARCHITECTURE & BUILDING

The Practical and Impractical in Architecture.

In "Architectural Education for America," by Barr Ferree, in No. 6, Vol. III, of *The Architectural Review*, the author partly coincides with the view that a knowledge of all the multitudinous things that enter into architectural practice is not needed to insure good design. At the same time he does not use the word practical as indicating such an intimate knowledge of common details,—for example, "the relative value of variously insulated wires," etc.,—and goes on to state what he considers practical and impractical in architecture.

"The practical in architecture means a full understanding of the actual conditions under which modern buildings are erected. An architect fails to meet the requirements of practicability in architecture today when, for example, being called upon to design a monumental memorial, he presents a gigantic scheme, with subsidiary buildings, terraces, colonnades, extensive gardens, and a multitude of minutiæ, very charming to look at, no doubt, but conceived on too grand a scale to meet the practical and reasonable requirements of cost, even assuming the design were artistically beautiful, which is quite another thing. An architect is unpractical when, being able to think in one style only, he tries to apply it to every problem under the sun,—as when he seeks to design a twenty-story office building in the Renaissance, which is essentially a broad and low style. He is unpractical again when he designs a humble country house at moderate cost in a 'monumental' manner. He is unpractical when he submits to a client a design calling for the expenditure of 20, 30, 50, or even 100 per cent. more than he has asked for. He is unpractical when he insists on style instead of on common-sense solutions of ordinary problems. He is unpractical when he overloads his designs with ornament, when he intrudes his own personality upon it, when he does not consider atmospheric conditions or location of site, when he does not carefully distinguish the use of materials in diverse localities, when he introduces vagaries into his work, when he designs in the clouds or in the fifteenth or sixteenth centuries, instead of on the earth in the nineteenth,—in fine, whenever, architecturally, he does those things he ought not to do. He may not himself need to be an expert on wires, but he must know that the man he employs to attend to that detail for him will do what is best; not a blind trust in another, but actual personal knowledge of the other's ability to judge and serve him. I should not like to set a limit to the practical knowledge he should have of materials and of construction, of health and life, of the requirements necessitated by the uses to which his building is to be put."

Mr. Ferree's article is in the nature of a critique upon an article by Mr. Albert L. Brockway, printed in a previous number of *The Architectural Review*. He corrects the statement made by Mr. Brockway that four articles, written respectively by Arthur Rotch, Robert D. Andrews, R. W. Gibbon, and Mr. Ferree, contributed to Vol. VII of *The Engineering Magazine*, "were published with the view of demonstrating that architectural education in America should be different from that of any or all other civilized countries." The articles were published with no such end in view. "The gentlemen who wrote them were each asked to present the special claims and advantages of the system under which he had been trained; the articles were not printed in the interest of any one system, but simply that the distinctive characteristics of the chief systems by which the architects of to-day are trained might be brought together in a connected discussion. If, however, the effect of these articles, brought together for no other purpose than this, was to show that a different system of architectural education is needed in America from that which obtains in other lands, then they have produced a result that lies very near to my heart, for in such differentiation, specialization, and Americanization of our architectural education lies, I am very sure, the regeneration and salvation of our architecture."

The charge is made by Mr. Ferree that the training in the School of Fine Arts at Paris is essentially a paper training. "The problems presented to the students from year to year are, very much, as a matter of course, identical problems. And, in preparing his work, the student does not seek inspiration or suggestion from actual buildings, but from the previous paper designs of previous students. An artificial atmosphere of unreality and drawing-paper is thus created that it is the hardest thing in the world to escape from. And, when these gentlemen go forth into the world to produce actual buildings, they are hampered by the unreality of their training. The errors and misfortunes of most French buildings arise from the fact that the actual work is not carried out under the same untrammeled conditions that obtain in the school. The magnificent designs prepared for the Grand Prix, and which every student in the school views with bated breath and in awe-stricken attitudes, are simply exercises on drawing-paper that no one ever expects to build. In his very early days the present writer found vast amusement in manufacturing designs by spreading out colored cards on the floor; and very marvelous and stupendous designs they were, 'though I say it as shouldn't.' I fail to see any difference between that childish amusement and the exercise solemnly performed by grown men in the School of Fine Arts at Paris. It is paper from beginning to end; only in the Paris case there is distinction to be gained among one's fellow-students, and, in the end, perhaps a diploma from the government of the French republic. The paper results are, as a rule, more satisfactory than those in brick and stone. Are we, then, to have a paper architecture in America?

"We need an architectural education for American architects that will serve American needs and answer American conditions. The Beaux-Arts men get so far up in the clouds with their paper designs that they often find it difficult to come down to the hard realities under which architecture is carried on in this country. More than this, they are hampered by feeling for a style, or for styles that do not readily lend themselves to the many varied structures called for in American life. Be their principles what they may, they are, with few exceptions, stylists who think and work in one style all the time, entirely oblivious of the fact that they cannot do with a style something that, in the very nature of the problem, is wholly foreign to it."

The New City Hall, Jersey City, N. J.

THE ARCHITECTURAL RECORD (July-September) makes the design of this building the subject of a caustic, specific criticism, and speaks generally of suburban public architecture as being "always particularly vile." The truth of this proposition must be conceded. The suburban districts of a city ought to be one of its most attractive features, but almost invariably, when a school, a police station, a concert hall, or a library is erected in one of these districts, it becomes a more or less permanent disfigurement. Just why or how this comes about the article under review does not explain. Most people will refer it to political rottenness in municipal affairs.

The contrast between public and private architecture in suburban districts is particularly noticeable. One passes through a group of beautiful villas and cottages to a space whereon stands a handsome church (nowhere else does church architecture look so beautiful as among the graces of trees and shrubs and vines), and just opposite may stand a hideous structure that might be anything,—barn, factory, or lager-beer hall,—for all that its exterior reveals, its ugliness being in startling contrast with the beauty of its surroundings. For this there is not the slightest excuse, though there is a cause.

"Unluckily the projectors of suburban public buildings imitate the urban public buildings. To have an artistic suburban public building would require, first, a willingness to have the status of their municipality as a suburb expressed, and, secondly, discernment enough to choose an architect capable of expressing it. The first of these conditions is very apt to fail in all American municipal architecture, and this for the obvious reason that the inhabitants of an American town of the second or the third or the fourth class are apt not to acquiesce in the existing status of their town, but to lay out their public buildings on the scale of the town that they hope it will be when the 'boom' has been fulfilled,—to lay out their public buildings as part of the boom. Hence, even when they have the luck to fall in with a good architect, and when the design shows sensibility and scholarship, it is apt to be more 'cityfied' and pretentious than the facts warrant, and this pretentiousness is with difficulty distinguishable from vulgarity. When the municipality is a suburb, the suburbans are apt to project their works on a metropolitan scale. Thus one of the conditions precedent to an artistic and appropriate public building has failed. When the other fails also, and an incompetent designer undertakes to simulate a public building more solid and costly than his client can afford with an array of cheap finery, the resulting edifice fairly reeks of vulgarity, as reeks the new city hall of Jersey City."

The anonymous writer of this article makes his sarcasm of richer flavor by a vein of humor that runs through it all. "The illiterate and incompetent practitioner so strongly resembles himself, wherever found, that to have seen one of his works is to have seen them all. By a curious revenge of fate upon him, 'variety' is the thing he always aims at and never attains, and the more he struggles for variety and novelty, the more monotonous and trite he becomes. His method is always the same. He desires to get as many 'features' as possible in a given front; he desires to make each of his fronts as different as possible from the adjoining front. A piece of plain wall is his chief aversion. It seems to him that, if he does not 'do something' with it, he is not earning his money or vindicating his capacity. Lord Melbourne's famous question, 'Can't you let it alone?' never by any chance propounds itself to him. To give a front a countenance it is necessary to him to furnish it with a minimum of two noses and four ears. If he cannot put on more things for the money in cut stone, he cheerfully adds them in sheet metal. At all hazards he must have plenty of things, and his variety thus comes to mean nothing but thinginess.

"His procedure is illustrated with an amusing *naïveté* in the work now under consideration. His principal front has things enough for a front three times as long. At the centre, to begin with, there is a porch with two columns on each side, with composite capitals, inclosing a Romanesque entrance arch with two nookshafts on each side. One is amused to remark here, as elsewhere throughout the building, that the carving is done 'in place,' as if the sensitive soul of the designer could not be appeased without seeing its actual effect in execution,—an assumption which becomes wildly hilarious when applied to forms that are transferred bodily from the 'Stair Builders' Guide.'"

Omitting further criticisms of details, our purpose in this review being merely to show the emphasis laid upon the generally unsatisfactory character of suburban public architecture, we quote further the concluding paragraph only.

"If one encountered this disreputable structure in Oshkosh, he would say, how Oshkoshian!; in Peoria, how Peorian!—it is so rude and raw a travesty of the architecture of civilization. As a matter of fact, it is in one of the oldest settlements of the United States, and within a mile or less of it is a respectable dwelling erected in 1666. This is not the brutality of a blundering beginning, but the hopelessness of a completed degeneration. The building which expresses the municipal aspirations and standards of Jersey City, would be a standing disgrace to a municipality of South Dakota by its crudity and vulgarity.

The Age of Brick.

UNDER this title *The Canadian Architect and Builder* prints an article which presents the claims of brick to be regarded as the best building material known to architecture. While many of the finest buildings of the early Christian period have fallen into utter decay, the most perfect buildings that have survived from ancient periods are of brick. Many of those composed partly of brick and partly of stone are in a fair state of preservation, and "not a single one of the great buildings composed of bricks altogether is known to have disappeared."

"In fact, the most perfect buildings that have come down to us from the earliest days are built of bricks, and we have evidence in a thousand and one instances of the superior lasting properties of bricks over all other known building materials, The Pantheon, the building of which dates back more than a century beyond our era, is built of bricks backed up with concrete, and, despite the bandit and barbarism, and the tooth of time, it still remains almost entire, as an object lesson in the use of bricks. The great Gothic Church of San Stefano, Venice, though badly designed and worse constructed, shows the bricks of which it is built to be as sound and shapely as when first laid, though held together by a very inferior mortar.

"The Triumphal Arch erected at Rimini in honor of Augustus is partly constructed of bricks, and partly of marble; but, while the marble is nearly rotten and dropping to pieces, the despised bricks remain perfect, and hold together the whole structure and its decaying aristocratic veneering.

"By far the oldest pyramid is of brick, —the one of Sakhara, said to have been erected more than a thousand years before Jacob wandered into Egypt. It still holds together, and gives promise of being a thing of mystery for a few thousands of years more. Indeed, we believe the Pyramid of Sakhara is supposed to be the oldest structure known. The temple of Thebes and the great Pyramids of Gizeh are modern by comparison."

Material for the manufacture of bricks is abundant and widely distributed in easily accessible places. The manufacture of plain bricks is easy. It is a better non-conductor of heat than stone; it resists climatic influences better; it withstands the action of intense heat; and, when well made, its strength compares well with that of stone. "It can be carved, if necessary, with considerable definiteness, and it costs less than stone." Recent advances in brick manufacture are great. "In olden times the architect was obliged to have all his moulded and ornamental bricks made by inexperienced workmen, under his own supervision. In the construction of a large building of brick the brick-maker was one of the architect's staff, and made his bricks to the order of his superior. His appliances for making and burning were of the crudest sort, and, as we know from examination, old bricks were often badly burned. To-day the architect may choose his bricks from catalogues, making his own choice of shape, quality, and color, and can rely on getting what he orders; and he can order to suit his design, whereas the old builders were obliged in almost every case to make their designs to suit the materials available."

The Durant System of Hollow Terra Cotta Construction.

ALTHOUGH during the last quarter of this century much use has been made of hollowed blocks of baked clay in buildings, *Brick* for June says that the possibilities of utility and beauty wrapped up in them have been hidden. It presents a color-plate of a Romanesque residence which, excepting the foundation, is built wholly of hollow terra cotta building blocks, adducing this as proof of the beauty of the material, and of its capabilities for producing structures of the highest order of artistic merit. Certainly the structure looks exceedingly well on paper. Interesting sketches of details of this building are shown, which illustrate possibilities of the system under consideration.

The basement is built of rock-faced blocks, imitating very exactly coursed-dressed ashlar; and the upper walls are a good imitation of broken ashlar work. The tables, belt courses, window-sills, and casings are all artistic. It is explained that this transformation from the coarse and "unpresentable hollow block of the past is all accomplished by affixing to the discharge ends of the die of an ordinary auger brick- or tile-machine a roller die which is operated by the moving mass of clay.

"A clay that can be vitrified without too hard a burn to change its color is desired; a plastic or bastard fire-clay is found very satisfactory, and shale clays with proper plasticity are equally desirable. Good clays are always found in abundance wherever coal is found, and in many other localities. The clays named are preferred as not absorbing moisture, and hence are free from discoloration from efflorescence, etc., and are also unaffected by freezing and thawing. They can be glazed or otherwise, as preferred, with no addition to their cost for glazing. For foundations, glazing is considered very desirable, and many prefer glazed casings, trimmings, etc., as it gives variety and brightness. These blocks weigh about four-tenths as much as brick of the same cubic space, and hence will widely extend the area of the manufacturers' market. Eastern Ohio manufacturers ship to Boston and Chicago."

To ornament the blocks is easy, but this is not alone sufficient; "they must have a good mortar joint to stand the weather to make them first-class, and must comprise a good door and window casing that can lock into the wall and hold securely the frame as against any contingency. But there is much more connected with ornamentation; as the introduction of color to bring out boldly the design imprinted, and also to color tuck-pointed joints, as in the case of the broken ashlar blocks, all being done by the one process at the mouth of the die and the colors burned in. Then the blocks must be perforated for piping, wiring, ventilating, etc., the perforating being simultaneous with the ornamentation and at both the top and bottom of the block." The machinery is said to be well planned for these last improvements, but is not yet on the market. The perforation improves the blocks; they burn more evenly, fuel is saved, and in a day's run 3 to 4½ tons of clay are saved, with the consequent saving in freights. It is said further that this system of building admits of improved heating and ventilation, and that the strength of the foundation blocks is such that, with the furniture in the building, only ¾ per cent. of the total crushing pressure is put upon the lowest tier of the foundation blocks.

Bronze Doors.

THE AMERICAN ARCHITECT (July 13), in an answer to newspaper criticisms upon the sculpture and other decorations of the Boston Public Library, incidently questions the wisdom and propriety of decorating bronze doors in such frequented buildings. On this point it says: "The labor and skill consumed in producing bronze doors is in large measure waste effort, since to be appreciated bronze doors need to be closed, and a library with closed doors is hardly a profitable institution. As the doorways are hardly wide enough to allow the construction of a *guichet* in one valve of each door, these bronze doors of French's must, save on holidays, stand open, and his work must be seen imperfectly by the aid of internal or reflected light without the aid and accent of direct cast shadows. Moreover, people who wish to examine his work at their leisure can only do so under penalty of becoming nuisances through forming obstructions to free and unobstructed passage through the doorways; and the chief use of doorways is to afford such passage, and not to constitute an art gallery."

An answer is also made to the prudish objections raised in some quarters against the nude bacchante by MacMonnies presented to the library by Mr. McKim, and which will adorn and grace the courtyard. In this case, it is thought, a concession ought to have been made to the objectors, or the class represented by them. "The vigor of the attack by those of prudish inclinations and the citations they made from classic authorities was only equalled by the quickness with which the defenders discovered other citations, and upheld the modesty and virtue of the priestesses of

Bacchus. In this case, as in that of the *putti* on the front of the building, we, while not sharing in any way the prejudice against the nude in art, feel that, since there are very many respectable people who prefer that their art works should present the skill of the human tailor rather than that of the Creator, it is a mistake in the case of a public building to please one portion of the public at the expense of another. From one point of view we are very glad that the 'Bacchante' is to find a place at the library, since it will show that MacMonnies is capable of doing better work than is represented by the sketchy and theatrical figure of Sir Harry Vane, which at present stands somewhat disconsolately in an upper room of the special library floor, and is apparently wondering why any one ever thought of placing his bulk indoors."

Protecting Roofs from Fire.

THE IRON AGE prints a circular prepared by a Boston fire insurance company and calling attention to a danger which, the company says, has been disclosed in the four principal losses to which it has been subjected in machine and metal works,—to wit, the risk of wide areas of wooden surface in the roofs of foundries, steel works, and the like. It is explained that "the danger does not consist in any great liability of fire originating in these roofs or upon the extensive surfaces of wood. The four fires which have caused heavy losses have all originated in some other part of the works, from which they have extended to the roofs or other extensive wooden surfaces and have there exerted their destructive influence."

The circular invites suggestions to aid the company in providing against the special hazard named. We venture to offer such a suggestion. Raise the rate to a figure which will inhibit owners from using such roofs. Wooden roofs are not a necessity for the class of dwellings named. A caution is made against the use of varnish, though the connection between their use and foundry roofs, etc., is not very apparent. We do not remember to have seen such roofs varnished. "A good coat of whitewash or kalsomine serves to retard the rapid spread of fire, but varnishes, or other finish in which oil, resin, turpentine, and sometimes benzine are used, should be absolutely refused admission into any building which it is intended to protect from loss by fire." But better than kalsomine, better than anything else as a preventive, is an advance in rates, or, in case of mutual coöperative insurance associations, a total refusal to admit such risks.

THE fall of the building at West Broadway and West Third Street, New York, on August 8, by which fifteen lives were lost, seems to be another one of those conspicuous examples of distributed neglect for which the annals of building in New York have become famous. Architect, contractors, the building department, each and all seem to have neglected their duties, the result being a catastrophe much too common in these days of skin building.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

*10. The Architecture of Modern Hospitals. Ill. E. C. Gardner. (Their interior design and location.) Eng Mag-Sept. 4500 w.

59. Architectural Education for America. Barr Ferree (A critique on an article by Mr. Albert L. Brockway; a discussion of the practical in architecture, and a plea for an architectural education for American architects that will serve American needs and answer American conditions). Arch Rev-Vol. III. No. VI. 5000 w.

84. Steel Framework for Minneapolis, Minn., Court House Roof. Ill. (Problems in design; system of trusses). Eng News-July 11. 1100 w.

†128. Ancient Methods of Spanning Openings and Spaces. J. B. (Ancient practice in India; ingenious use of stone beams). Ind Engng-June 8. 1900 w.

184. English Country Churches. Ill. A. B. Bibb (An architectural study of rural English ecclesiastical architecture from the art standpoint). Am Arch-July 13. 1700 w.

185. Delphi (The French excavations from the engineer's plan). Am Arch-July 13. 5000 w.

186. Boston Public Library (Editorial reply to newspaper criticisms). Am Arch-July 13. 600 w.

We supply copies of these articles. See introductory.

*191. John Sell Cotman and Architecture (His work with specimen illustrations. His place among landscapists and architectural draftsmen). Arch, Lond-July 5. 1400 w.

*192. Architectural Antiquities of Normandy. Arch, Lond-July 5. Serial. 1st part. 1500 w.

*193. Abbey Church of St. Stephen, Caen (Historical and descriptive). Arch, Lond-July 5. Serial. 1st part. 4800 w.

*214. The Representation of Architecture at the Royal Academy (Criticisms—editorial, and extracts from letters to the editor; much dissatisfaction expressed). Builder, Lond-July 6. 5400 w.

*215. A New Roman Catholic Cathedral at Westminster (Descriptive). Builder, Lond-July 6. 1200 w.

*216. Metals Used in Building. Serial (Will describe the ores from which the metals are obtained, alloys and mixtures of metals, casting, moulding, etc., of metals for architectural work in England). Builder, Lond-July 6. 1st part. 1300 w.

264. Protecting Roofs from Fire (States a special hazard in wide areas of wooden roofs, in foundries, steel works, paper works, &c. and invites suggestions for prevention). Ir Age-July 18. 1500 w.

300. Masons and Builders' Schools in Germany (From a recent consular report. Gives the most recent practical and theoretical knowledge obtainable). Arch & Build-July 20. 1500 w.

301. Sound in its Relation to Buildings. H. W. Burrows (Review of late opinions). Arch & Build-July 20. Serial. 1st part. 3000 w.

*306. Architecture in London. Ill. Barr Ferree (Characteristics; materials; sloping roofs; modern buildings, etc). Arch Rec-July-Sept. 9500 w.

*307. A French Dining-Room of the Upper Middle-Class Type. Ill. Fernand Mazade. Arch Rec-July-Sept. 4000 w.

*308. The Royal Polytechnikum at Berlin and Student Life in Germany. Ill. Albert F. M. Lange (College for the study of architecture, engineering, mining and chemistry). Arch Rec-July-Sept. Serial. 1st part. 3000 w.

*309. Architectural Aberrations. The New City Hall, Jersey City, N. J. Ill. Arch Rec-July-Sept. 1500 w.

*310. The Education of an Architect. Henry Rutgers Marshall (Some of the general principles which should guide us in giving this education). Arch Rec-July-Sept. 7000 w.

*318. The Age of Brick. F. T. H. (Attempt to prove it durable and the best and most natural building material). Can Arch & Build-July. 900 w.

325. Switzerland's Building-Material Station (For the testing of building material. A branch attached to the Federal Polytechnic School at Zurich). Eugene Germain. Am Arch-July 20. 900 w.

*326. Architectural Antiquities of Normandy. Abbey of the Holy Trinity of Caen. Ill. Arch, Lond-July 12. Serial. 1st part. 2500 w.

329.—$1.50. "Frauds and Abuses at St. Paul's," 1712 (An attack by one Dr. Hare upon Sir Christopher Wren, and the latter's reply. An interesting historical note). Jour Roy Inst of Brit Arch-July. 700 w.

330.—$1.50. Tour of the Pugin Students 1894. Ill. (An interesting description of an English tour with sketches of architecture in many towns). Jour Roy Inst of Brit Arch-July. 3000 w.

331.—$1 50. Philadelphia: An Architect's Notes in an American City. H. Bloomfield Bare (How an English architect regards the Quaker City architecture). Jour Roy Inst of Brit Arch-July. 5000 w.

332.—$1.50. Theoretical and Practical Notes on Beams, Columns, and Roof Trusses. J. M. Moncrieff (A very important, exhaustive and instructive paper. The experiments with brick cantilevers will be interesting to many readers). Jour of Roy Inst of Brit Arch-July. 9000 w.

333.—$1.50. Art in Primitive Greece as Treated by Georges Perrot and Charles Chipiez. Ill. Francis C. Penrose (A critical review of the history of Art in Primitive Greece by the authors named). Jour Roy Inst of Brit Arch-July. 2500 w.

*343. Brownstone in New York City. R. S. Taite (Unjust prejudice). Stone-July. 1300 w.

†396. Some Characteristics of Pre-Conquest Architecture. Gerald Baldwin Brown. In Arch-July. Serial. 1st part. 6400 w.

*429. Colored Brick. R. C. S. (The danger of color in the hands of the inexperienced. Workmanship of more importance than material). Br Build-July. 1100 w.

*430. Terra-Cotta Fragments. Ill. Fritz Wagner. By permission of Clay-Worker (In proof that terra-cotta can be used constructively for classic cornices). Br Build-July. 900 w.

438. The Railroad Shops at Wabash, Ind. Ill. (Plan, details, trusses, columns, girders). Ry Rev-July 27. 700 w.

*466. The Building Laws of Byzantium (Emperor Zeno's building law the admiration of Roman jurists). Arch, Lond-July 19. 2500 w.

*467. The Sanitary Aspects of the London Building Act, 1894 (A paper by G. Blundell Longstaff read at a meeting of the Sanitary Inst). Arch, Lond-July 19. 4300 w.

590. Berlin Tenement-Houses (Report of Consul-General Charles DeKay in response to interrogatories sent out by Committee). Am Arch-Aug. 3. 3000 w.

591. A Syllabus of Early Christian, Romanesque and Gothic Architecture. M. Wergeland. Am Arch-Aug. 3. Serial. 1st part. 2700 w.

592. Mural Decoration in Situ. Frederic Crowninshield (In favor). Am Arch-Aug. 3. 700 w.

648. Portland Cement Concrete for Architectural Decorations. Ill. (A plea for a better appreciation of the possibilities of concrete in decorated architecture). Eng News-Aug. 8. 800 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Adulterated Portland Cement and Blast Furnace Slag.

THE *Engineering and Mining Jonrnal* of July 6 contains an article by A. D. Elbers, entitled "Adulterated Portland Cement and Blast Furnace Slag," that is of especial interest to all engineers. After explaining the origin of what is now termed Portland cement,—*viz.*, that it was an English invention made in imitation of an earlier English cement called Roman cement, made by burning an argillaceous limestone or calcareous clay into a cement and named "Portland" because of the similarity of its color to that of the famous Portland building stone,—he goes on to the definition of this product, which is as follows: "A material made from natural or artificial mixtures, consisting of clay and carbonate of lime, that contain the essential ingredients of these substances in certain relative proportions, and that have been subjected to an intense heat until all of the lime has become chemically combined with the other ingredients."

What the resulting compounds represent—whether they are compound silicates of alumina and lime or a mixture of aluminates and silicates of lime, etc.—he does not undertake to decide, but inclines to the opinion that the mixture must be such that, if completely fused, its basicity would be such that the alumina would play the *rôle* of an acid. He does not believe that in the manufacture of Portland cement such a reaction takes place, or that it can take place, because at the temperature of manufacture "the burning happens to be regulated in such a manner that the hard frittering or sintering masses of clay and lime begin to cool off when the silicate of alumina is just on the verge of splitting up into silica and alumina, which tendency is materially assisted by the presence of ferric oxid, or even of calcium ferrate."

He cites several facts of observation to substantiate his view of the correctness of his theory, the first of which is this: "In cooling, overburned cement either crumbles or falls to powder, just like slacking blast furnace cinder, whereas well-burned cement stock remains so solid that it has to be broken out of the furnace with crowbars. But the specific gravity of well-burned as well as of underburned cement is greater than that of overburned stock of the same composition, which shows that the overburned must have undergone an additional chemical change, and that change is apt to consist in the more copious formation of aluminates. Both overburned cement and slacking blast furnace sinder set in water, but the hardening of the set masses does not amount to much. It is therefore to be assumed that the most of the alumina of the normal cement is still in the condition of a silicate constituent, and that the setting capacity of the normal cement is chiefly due to its large contents of silicates, that are so basic that they change readily to hydrosilicates when mixed with water, the latter playing in this case the *rôle* of an acid" (*sic*).

He thinks that this silicifying process (upon which the hardening depends) may be intensified in Portland cements by mixing it with silicates "that yield a great deal more of gelatinous silica than is set free by the decomposition of its own silicates," —whatever that may mean.

The failure of the many attempts to make a saleable cement from blast furnace slag and lime he attributes to the erroneous idea that, in burning such compositions, the lime of the slag would have the same effect as an equivalent amount of admixed free lime, and that, consequently, only a small proportion of the latter would have to be added to the slag, "whereas the strength of cement depends on the very condition that the silicate of alumina has been reacted upon by free lime."

He regards the lime of the slag, so far as its useful effect for this purpose is concerned, as useless.

He thinks that the composition of the

Portland cement *before it is burned* is not likely to be adulterated, because the resulting product would be so inferior to that from the ordinary raw material that there would be no inducement.

"On the other hand," he says, "adulterations of the burned stock, made either before or after it is ground, may escape detection." Some so-called adulterations —*viz.*, the addition of puzzolane, etc.—he thinks may be of actual benefit, since "the genuine Portland is rather deficient in the proportion of its soluble silica as compared with that of the lime that dissolves with the silica." He says: "It is, therefore, an open question whether the ultimate hardness of pure and finely-pulverized Portland could not be considerably increased by such admixtures" (Mass Santorin earth and puzzolane).

Now, while blast furnace sinder of the singulo-silicate type would seem to offer a good substitute for these admixtures, and should theoretically fill the bill, he points out that the singulo-silicate slags contain impurities that are not permissible,—the first of these is sulphur, which is most antagonistic,—and, if free from sulphur because very acid would defeat the very object for which it was added.

"As to the utilization of blast furnace cinder for cementing purposes," he says, "it is not likely that it will ever amount to much until sulphurous slag is desulphurized by some cheap method. But, whenever that is accomplished, then the genuine Portland cements, as well as the hydraulic mortars that are made from volcanic earth, will meet with serious competition."

This calls to mind a natural cement, somewhat resembling puzzolane, which is found over very extended areas of Mexico, but is apparently unknown in this country. It is a superficial deposit, evidently the result of the decomposition of the volcanic rocks, and in its purer state almost perfectly white. It is prepared for use by burning and then quenching with water in order to bring it into a pulverulent state. It is then mixed with one-third or two-thirds the quantity of sand or loam and sufficient water. It is an exceedingly tenacious cement, has excellent hydraulic qualities when properly mixed, and is used almost exclusively in some portions of Mexico. It is largely due to this cement that the older stone structures in that country remain in their remarkable state of preservation, and it is exceedingly strange that an article of such merit, so near our doors, has gone unnoticed.

The Effects of Low Temperature on Iron and Steel.

THE *Engineering Record* of July 13 discusses editorially the effects of low temperature on iron and steel. It calls attention to the fact that, although experiments were instituted as far back as 30 to 40 years ago to determine this question by the best authorities and have been continued up to the present time, it is still an unsettled question. The investigations of Sandberg and Styffe, and the results of the extended observations made on steel rails in use in all seasons of the year in Russia, as well as the more recent experimental work of Mr. Thomas Andrews, F. R. S., all go to show the unreliability of present data, because of their contradictory testimony. It says: "As a matter of fact, it is not incautious to state that not even such an intimation (as to the law which governs the variation of strength of iron and steel with temperature) can yet be discovered in all the results of this experimental work, at the very beginning of which Styffe and Sandberg arrived at diametrically opposite conclusions, the latter maintaining that the capacity of resistance to impact of iron rails, as well as their ductility and flexibility, was very seriously impaired at a temperature of 10° F., while Styffe confidently concluded that neither the ultimate resistance nor the ductility of either iron or steel was sensibly affected 'at the lowest temperature which ever occurs in Sweden.'"

"It has sometimes appeared that steel rails are somewhat more liable to break under traffic in winter than in summer, but, on the other hand, the statistics drawn from railway experience in such cold climates as those of Russia and the State of Massachusetts usually substantiate a conclusion of an opposite character. The later experiments of Mr. Andrews were made upon car-axles, which were submitted to impact up to failure at low and high temperatures obtained by freezing mixtures and hot water respectively. These investigations were continued throughout a period of several years, and seemed to indicate that the resilience, or capacity to resist impact, of the iron used in the axles was considerably less, perhaps even one-third or one-half, at the low temperatures than at the high. The results of these experiments, it is thus seen, at first sight contravene the conclusions which may be based apparently upon perhaps the greater portion of the earlier experience and experimental work."

It goes on to say, however, that it is not only possible, but highly probable, that one or two elements have not been considered.

"Wrought iron, which contains from $\frac{1}{10}$ to $\frac{25}{100}$ per cent. phosphorus, has too much of that prejudicial element for many purposes, and there is much evidence which cannot be ignored, pointing to the conclusion that such metal may be seriously affected by a low temperature which would have little or no effect upon wrought iron containing sensibly less phosphorus. In fact, it is undoubtedly true that the presence of that element affects very seriously the capacity of either iron or steel to resist impact, nor do we believe that any safe conclusions can be based upon experimental work in this field without giving a careful quantitative recognition, so to speak, to the chemical constitution of the metal tested."

It accounts for the contradictory testimony on this ground, therefore,—which is certainly well taken,—that physical tests of any kind are of little value, unless the chemical constitution of the material tested is accurately known. Phosphorus is but one, although an important, element that controls or has an influence upon the physical qualities of iron and steel. It is becoming of less importance because of the improved methods of manufacture which render its presence less conspicuous to-day, even in metal produced from high phosphorus ores, than it formerly was in that produced from the better grades. Modern investigation has shown such a controlling influence of other impurities in minute proportions as was not suspected before, and this, in the absence of information as to the exact composition of the material tested, renders, as the *Engineering Record* maintains, previous data of little value.

The editorial concludes with the following statement. "There is, again, another aspect of this question which has never yet been investigated, and that is the elastic endurance of iron or steel at low temperatures, even though it contains a relatively high percentage of phosphorus. There is an enormous amount of metallic structural work in which no member is ever supposed to be stressed anywhere near its elastic limit, and it is a matter of great practical importance to determine whether the endurance of metal under such conditions can ever be affected by low temperature. Indeed, this whole question is one of many phases, and we are strongly of the opinion that safe conclusions will never be reached until the full effects of those influences which we have pointed out are recognized, and, when they are recognized, we believe it will be found that phosphorus is one of the most active elements in the impairment of ultimate resistance and ductility, at low temperatures."

Stream Measurements.

AT a meeting of the Engineers' Club of Philadelphia Mr. F. H. Newell presented an interesting paper on the methods and results of stream measurements by the United States Geological Survey; and the paper is given, with illustrations of current meters and charts of some typical observations, in the *Proceedings* of the club for July. After reference to the importance of hydrographic work as a basis for irrigation, power, or municipal water-supply engineering enterprises, the author explains that, in the selection of river stations for observations, it is of course impracticable to measure all or most streams, but that, if one or more important rivers in each State can be measured, the results possibly can be applied to other streams coming from catchment basins of similar altitude and under like climatic conditions. The points selected in each of the larger drainage basins were usually near railroads, and, wherever practicable, river gages were attached to railroad bridges, records being kept by employees of the roads. As it is impossible to make direct measurements of the quantity of water flowing day by day in many streams without great expense, the less direct method of height gaging has been resorted to. For this two classes of observers are required: the one to keep regular readings of the height of water at short intervals throughout the year; the other to make measurements of quantity, such that the relation of height of water to discharge may be known. This relation is not exactly fixed, varying somewhat according as a river is rising, falling, or stationary, and is also modified by the direction of the wind. But, by comparing meter and gage measurements and plotting the results on cross-section paper, a mean rating curve is obtained which answers in ordinary cases. From the curve thus obtained, values are taken for each tenth-of-foot gage reading, constituting a table from which the discharge corresponding to any given height can be had.

For keeping record of height of water many automatic instruments have been devised, some of great ingenuity; but the author says that for the purpose of the work of the geological survey it has been found, after many trials, that better results can be obtained by the simple method of having a man residing near the spot note down once, twice, or three times a day the height of water upon a suitable device, or measure it directly. Mr. Newell reports that the recording nilometers, or tide gages, give excellent results when carefully installed and when they can be watched by skilled men, but that almost without exception they fail when placed in charge of the ordinary unskilled man. If several hundred dollars were spent in a thorough equipment at each station, and in such protection that an instrument could be left safe from meddling, it would be possible to obtain very accurate continuous records, but economy forbids the use of this method on an extensive scale. The river gages are usually vertical rods marked in feet and tenths. Occasionally inclined rods, following the slope of the bank, are used, these being marked to equivalent vertical feet and tenths. In a few cases the height of water is ascertained by a weight lowered by wire from a bridge.

Floats are occasionally used for measuring quantities of water, but for convenience and economy of time some form of current meter is preferred. It is, of course, impracticable to construct weirs on streams of considerable size, but dams already constructed are sometimes utilized for measuring discharge. Several meters are figured in Mr. Newell's paper, two types being shown,—the horizontal cup wheel and the propeller style. A favorite form is the latter, with a two-fluke wheel, used on a rod, or suspended by cord from a bridge or other support, or swung over a stream and lowered to any desired point by means of suitable light cables and trolleys. This meter records electrically, and, as Mr. Newell observes, has, like similar electrical devices, the disadvantage of getting out of order, when in the field, in the most aggravating manner. Long search was made for some form of electric battery convenient for field work,—light, portable, strong, and reliable. Nearly every kind of dry battery was tried, and given up in favor of the more cumbersome wet cell, which, though bulky and liable to breakage, could be depended upon. Finally a very small bisulphate of mercury battery (only about 2 × 1 in.), as made for medical purposes, seems to be satisfactory, if cleaned and recharged at short intervals. The meters are used from a bridge, a boat, or a suspended car. A bridge is most convenient, if its piers do not obstruct the current. At most important points, however, bridges are not available; then, if the stream is not too wide, a wire cable is stretched across and a boat attached to the cable by a travelling trolley. The meter is then used from the bow of the boat, usually from a rod allowing it to be placed at various depths. Meters are tested by running them at known speeds through still water.

Wooden Bridges in Modern Practice.

ALTHOUGH the engineering text-books continue to give the usual matter about wooden bridges, it is seldom that they receive attention in current technical journalism or in the papers presented at the society meetings; and the common impression seems to be that they are interesting mainly from the historical point of view, and are now used only as temporary make-shifts or for insignificant spans. It is consequently refreshing to note that Mr. J. Parker Snow has taken the trouble to show what is now being done, as a matter of choice and in advanced practice. His paper on wooden-bridge construction on the Boston & Maine railroad (read before the Boston Society of Civil Engineers and published in the *Journal of the Association of Engineering Societies*, July, 1895) explains why the engineers of the progressive, well-equipped road to-day prefer wooden bridges—within due limitations, of course—to those of iron and steel, even where the best timber has to be brought long distances and where freights on metal are low.

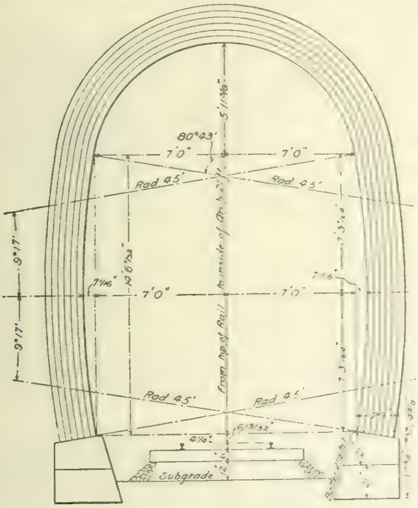
On the Boston & Maine there are 1085 wooden bridges out of a total of 1561, counting overhead as well as track bridges and everything of over 6 ft. span except stone culverts. While Mr. Snow admits that the proportion grows less yearly, still more than half the new structures built to replace old bridges are of wood. He enumerates pile trestles, plain stringer bridges, compound stringers of keyed timbers to get greater depth, pony trusses, and Town lattice bridges. The last named are of the most importance, on account of length of span. Mr. Snow considers the cost of well-built Howe trusses of considerable span about the same as that of iron bridges at present prices of material, which rules them out. For the Town lattices spruce is used mainly on the northern part of the system and Southern pine on the southern lines. Spruce, he says, is sufficiently durable when roofed in, and on account of its lightness is much better than Southern pine for lattices, though its softness and tendency to warp, and the difficulty of getting sticks of sufficient size, make it inferior for Howe truss work of magnitude. Although spruce exposed to the weather has a life of but about 6 or 7 years and Southern long-leaf pine 12 to 14, when roofed in and well ventilated either timber will last 40 to 50 years; and in the discussion of the paper Mr. B. W. Guppy cited cases of wooden railroad bridges lasting from 45 to over 50 years. The cost of various bridges for single-track of 120-ft. span is stated as follows: iron, $5300; Howe truss of Southern pine with iron angle blocks, $5000; spruce lattice, $3500. Below this point the advantage of wooden construction in point of cost will increase, and above it the advantage rapidly decreases to nothing. Details of lattice work and diagrams showing method of building are given very fully by Mr. Snow.

In the discussion of the paper Mr. Guppy added some interesting information as to wooden bridges, and the Town lattice in particular. He said that in use these bridges stand a great deal of abuse, and quoted instances of serious collisions and washouts which left them serviceable. He remarked upon one valuable property of a timber bridge, — its certainty of giving warning of approaching weakness,—which has kept the record of wooden truss bridges so clear from fatal disasters. It is not reasonably safe to use a light iron bridge until it is nearly worn out, but a wooden one may be used until its deterioration is rapidly approaching the end. Fire is the principal enemy of such bridges, but the danger has become much less since the introduction of coal-burning engines. Proper precautions are suggested.

Neither Mr. Snow or Mr. Guppy wish to be understood as preferring timber to iron or steel apart from the question of cost; but it must be admitted that, within reasonable limitations, they make out a strong case for wooden bridges, so that, far from being obsolete and in bad practice, the building of such bridges is a live business to-day, under conditions of fair competition.

Re-lining a Weakened Tunnel.

THE Patton tunnel, near Taswell, on the Louisville, Evansville & St. Louis railroad, has long been a source of annoyance, its wooden lining having caught fire some years ago, when large quantities of earth and rock fell in, stopping all traffic until it was cleared and the timber lining repaired,—a period of three months. Since then similar trouble has always been feared, it having been noticed that the material over the tunnel had become loosened almost to the top of the hill. It was supposed that the only remedy would be an open cut or a new tunnel. The *Railroad Gazette* (July 26) gives the following account of how Mr. T. A. Allen, chief engineer of the road, met the emergency by relining the old tunnel with brick. A section of the tunnel is shown in the accompanying cut. The line is single track, stone ballasted, having new oak ties laid with 90-lb. rails. The tunnel proper is 775 ft. long, although the entire length of the work in question was 1200 ft., there being, in addition to the tunnel, an embankment and entrance walls. The walls and arch are of vitrified brick and stone, the center of the arch being 21 ft. above the rails. The width of the tunnel is 15 ft., the walls being composed of six rings of brick. During the construction of the work, traffic on the road was not interrupted, the sides and roof of the tunnel being supported by temporary timbering. The track was temporarily supported on 12-in. × 12-in. stringers 10 ft. long between supports during the building of the invert. The bricks used were of the best quality, hard-burned paving-brick, tested for 4000 lbs. pressure per square inch without crushing. They were laid in cement mortar in proportion of one part of cement to two of sand. The cement was required to show 100 lbs. tensile strength per square inch without breaking, 7 days after mixing. The bricks were laid with the English bond, having five stretcher courses to one header course. No headers were used in the arch. Concrete or clay was used for packing the space between the sides of the tunnel and the brick walls, the former being used for foundation beds for the walls and invert, when so specified.



The Patton Tunnel – L. E. & St. L. R. R

The Canadian and American Sault Ste. Marie Canals.

SPEAKING of the recent formal opening for traffic of that important undertaking, the canal on the Canadian side of the "Soo," by the Dominion government, London *Transport* (July 10) explains that this waterway will give continuous navigation for about 2384 miles, from the head of Lake Superior to the sea,—and might add that it has the advantage of keeping this navigation within Dominion lines, while the American canal furnishes only a partial exit for American vessels within their own boundaries. *Transport* also gives some interesting historical notes, from which it appears that the waterway had its real beginning so far back as 1793, in a wooden lock constructed for the boats of the Montreal Fur Company. Development has been slow, but in May, 1893, work was commenced on the new canal and lock. The latter is 900 ft. long, 60 ft. wide, and 22 ft. deep below the lowest recorded river level. The masonry walls extend on each side 1106 ft., and they are 11 ft. wide at the top and 20 ft. wide at the bottom, while around the gates they have a uniform thickness of 25 ft. There are three sets of gates at the eastern end. One is a guard gate to be used only in emptying for repairs; one is a spare set to be used in case of accident to the outer gate, the latter being in regular use. At the upper end there is a main and a guard gate. The draw-bridge over the Canadian lock has an opening of 90 ft. Across the island the canal is 3500 ft. long, 152 ft. wide at low-water level, and 145 ft. wide at the bottom. The low-water depth is 20 ft. The total cost involved by the construction of the canal is £4,000,000.

In this connection *Transport* also refers to the second and far larger lock on the American side, and gives some figures relating to it. This lock is to be 1124 ft. in length, or 800 ft. between the quoins of the main gates, and 100 ft. in width. The depth on the mitre sill is to be 21 ft. at ordinary low stages, and the lift 18 ft. The site has been excavated down to a base of solid rock, and the foundations for the walls and floors have been built up to the required height with concrete. The gates are to be of arch form, and will be built mainly of low steel. The lock will be filled from a pit in the floor of the upper gate chamber, and the water will enter the chamber from the culverts through two hundred and fourteen openings in the floor. The emptying valves are similarly placed against the down-stream face of the lower pit. To empty the lock the water passes from the pit through culverts to a similar pit just above the lower guard gates, which is open to the lower level. A guard crib of timber, 64 ft. long, 20 ft. wide, and 28 ft. high, filled with stone, is being placed at each end of each wall. The walls are to be 43½ ft. high above the level of the chamber. The coffer-dam is 1500 ft. long and 300 ft. wide.

CHLORIDE of zinc paint, although virtually a water-color, dries quickly and hard, so that it can be washed with soap and water when necessary, and will be found a preservative of wood, rendering it almost incombustible.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

11. The New Brooklyn Terminal Station of the Brooklyn Bridge (Details new 4-track, 2-island platform system, train sheds, tail switching). Ill. Eng News-July 4. 3400 w.

40. Expansion Bearings for Bridge Superstructures. Ill. George S. Morison (Description of bearings and motion stops). Ry Rev-July 6. 600 w.

89. The Substructure for the Third Avenue Bridge, New York City (Pier construction by caisson and coffer dam). Eng Rec-July 6. 1000 w.

235. New Bridge Specifications (General specifications for railroad bridges; proportion of parts). Eng Rec-July 13. Serial. 1st part. 1700 w.

407. Elevated Structure, Merchants Bridge Terminal R. R., St. Louis, Mo. Ill. H. P. Taussig (Working drawings and description). Eng News-July 18. 1500 w.

410. Stresses in Plate Girders. Ill. Henry Goldmark (Cor. Two cases; deck and trough girders). Eng News-July 15. 900 w.

439. Length of Angle Bars. Jerry Sullivan (How stresses act). Ry Rev-July 27. 1400 w.

†521. Wreck of the Connersville (Ind.) Bridge and Its Temporary Repair. Ill. Joseph Kemper (Low trestle by-way). Pro Eng Club of Phila-July. 1700 w.

557. The Newport and Cincinnati Bridge. Ill. (Brief description; elevations and sections. R R Gaz-Aug. 2. 350 w.

649. Double Swing Bridge at Columbus St., Cleveland, O. Ill. (Descriptive). Eng News-Aug. 8. 1400 w.

Canals, Rivers and Harbors.

85. Concerning the Cost of Ship-Canals (Suez, Corinth, Baltic, Manchester, Nicaragua compared). Eng News-July 11. 1800 w.

88. The Chicago Canal and Lake Commerce (Editorial. Effect of lowering lake levels). Ir Age-July 4. 700 w.

*173. Drainage in the Fens. Ill. (River aqueducts; scouring dredge; ditches). Engng-July 5. 2000 w.

*296. The Clyde Docks Improvements (Hydraulic, electric and steam cranes; dredging). Ir & Steel Tr Jour-July 6. 2000 w.

441. The Drainage Canal and Lake Levels (Conservative views as to effects). Ry Rev-July 27. 1400 w.

*479. Glasgow Docks and Harbor Works (Dredging; cranes; pumping plant). Eng, Lond-July 19. 2300 w.

*620. The Improvement of the Port of Havre and of the Navigation of the Estuary of the Seine. Ill. (Developing a sandy estuary). Eng, Lond-July 26. 4000 w.

*621. The Waterloo and City Electric Railway. Ill. (Map and detailed sections). Eng, Lond-July 26. Serial. 1st part. 2200 w.

661—$1.50. The Santa Ana Canal.—Discussion and Correspondence on Paper by William Ham. Hall (J. J. R. Croes, William Barclay Parsons, L. L. Tribus, James Duane, R. C. Gemmell, Franklin Riffle, Charles W. Greene, James D. Schuyler, David C. Henry, L. J. Le Conte and William Ham. Hall). Tr Am Soc Civ Eng–June. 13000 w.

*674. Recent Engineering Improvements of the Clyde Navigation Company. James Deas (Particulars of the dredging machinery, and especially of the recent additions thereto, and the quantities and cost of the dredging in the harbor and river, etc.; and description of the present equipment of the harbor of Glasgow). Ind & Ir–Aug. 2. Serial. 1st part. 3800 w.

*676. Harbor Development on the South Coast (Folkestone and Dover). Trans–Aug. 2. 2000 w.

679. The Atlantic Coastwise Canal Across New Jersey. From report of N. H. Hutton. R R Gaz–Aug. 9. 600 w.

Hydraulics.

86. The Hydraulic Pump. Ill. Robert Ferriday (Experiments on back water). Eng News–July 11. 1200 w.

233. The Milwaukee Water-Works New Intake (Construction; completion; costs). Eng Rec–July 13. 1600 w.

236. The Jerome Park Reservoir. Ill. (Amount of work and materials). Eng Rec–July 13. Serial. 1st part. 900 w.

337. New Hydraulic Formulæ. Marvin E. Sullivan (Based upon the system of unit coefficients; with new theories of flow, and of the eroding power of water). Eng & Con–July 12. Serial. 1st part. 1700 w.

338. High-Service Water System, Manchester, N. H. Ill. (Details of system). Eng Rec–July 20. 1200 w.

411. A Computer for Determining Flow in Pipes by Kutter's Formula. Ill. (Application). Eng News–July 18. 1100 w.

424. The Chicago Ship Building Co.'s New Dry Dock. Ill. (Coffer dam construction; side-on launching). Eng News–July 25. 1000 w.

427. Goulburn Dam, Victoria, Australia. Ill. (Reprint of a rare monograph). Eng News–July 25. 2700 w.

†517. Methods and Results of Stream Measurements by the United States Geological Survey. Ill. F. H. Newell (Gages; current meters; records; discussion). Pro Eng Club of Phila–July. 8000 w.

†519. Coffer-Dams. Ill. William H. Dechant (Crib-work construction; clamping; sinking; puddling. Discussion). Pro Eng Club of Phila–July. 2600 w.

Irrigation.

†299. On Keeping Irrigation Canals Clear of Silt. Robert Burton Buckley (River works; head sluices; head catch basin; double sluice and setting tank system). Ind & East Eng–June 15. 1300 w.

452.—$1. A New Method of Determining Co-Efficients of Flow and of Resistance in Pipes and in Open Channels, and New Formulæ for Head, Diameter, Mean Hydraulic Radius, Velocity, etc., Based on This New Theory. Marvin E. Sullivan, with Discussion by Engineers (Mathematical). Am Soc Ir Eng–Jan. 8500 w.

Miscellany.

14. The Meaning of Elastic Limit in Steel Specifications (Experiments; specifications. Comments by William R. Webster. Reply by A. C. Cunningham). Eng News–July 4. 3000 w.

31. Adulterated Portland Cement and Blast Furnace Slag. A. D. Elbers (Chemical reactions. Practical results). Eng & Min Jour–July 6. 2200 w.

44. The Civil Engineer and His Work (Editorial reviews and comments on Mr. Morison's paper). Ry Rev–July 6. 1200 w.

†79. An Apparatus for Experimenting with the Laws of Flexure of Beams. Ill. James L. Greenleaf (Description of apparatus. Mathematical treatment of results). Jour Frank Inst–July. 1600 w.

231. The Effects of Low Temperature on Iron and Steel. Editorial (Inconclusive data and conflicting testimony). Eng Rec–July 13. 1200 w.

232. American Portland Cement. William G. Hartranft, with Editorial (History; merits; composition). Eng Rec–July 13. 3000 w.

234. Tunnel Disaster in Australia (Failure shield-driven heading; plugging with clay bags and loose clay). Eng Rec–July 13. 1400 w.

239. Hydraulic Caisson Foundations. Ill. (Site; telescopic steel cylinders; sinking; clearing; masonry piles). Eng Rec–July 13. 3300 w.

*353. Working in Compressed Air (Physiological effects). Engng, Lond–July 12. 1600 w.

428. The Elastic Limit and the Yield-Point (Literature reviewed. Comment by G. C. Henning). Eng News–July 25. 10500 w.

508. Hydraulic Caisson Sinking for Foundation Piers. Ill. (Open steel cylinders; water jets). Sci Am–Aug. 3. 600 w.

*631. The Civil Engineer (Editorial. The meaning of the term defined). Engng, Lond–July 26. 2200 w.

†655. "The True Column Formula" an Impossibility. James L. Greenleaf (Expresses the belief that a finite mind is incapable of stating a true column formula). Sch of Mines Quar–July. 1800 w.

659.—$1.50. Address of George S. Morison at the Annual Convention at the Hotel Pemberton, Hull, Mass. Tr Am Soc Civ Eng–June. 8400 w.

660.—$1.50. Painting of Iron Structures Exposed to Weather. E. Gerber, with Discussion (The most important recent contribution to the subject with voluminous correspondence from a large number of prominent engineers). Tr Am Soc Civ Eng–June. 55000 w.

DOMESTIC ENGINEERING

Fallacies of the Trap Vent Pipe System.

MR. J. W. HUGHES, in *Architecture and Building* (July 6), asserts that "complete and continuous ventilation through every part of a waste system is the Utopian ideal of the sanitary expert"; and he calls "the popular belief" that "such a circulation is secured by the observance of the commonly-accepted rules for house drainage" a delusion. He says: "It is simply impossible to maintain such circulation in the several parts of a pipe system constructed in accordance with these rules, especially where there are two or more vertical lines of pipe, where there are fixtures on two or more floors, or where there are many fixtures connected with the same system.

"It will be observed that the entire drainage system of each building, whether large or small, is discharged through a single outlet, and usually, though not always, disconnected from the sewer at the cellar wall by a running trap, with a fresh-air inlet connected with the drain on the house side of the trap, and extending to the outer air at the street curb. But the presence or absence of this trap and foot vent is not material to the question at issue. It must be remembered that circulation through these pipes is mainly dependent on the difference of temperature between the outer air and the air in the pipes. In winter, when the outer air is cold and the air in the pipes is warm, an upward current may be traced in one or more of the rising lines, while those more remote will show little or no circulation, for the reason that the single source of supply—the fresh-air inlet or the drain—is too limited to meet the demand in several rising lines, in which there is liable to be considerable difference of resistance. In summer, when the air in the pipes is frequently colder than the outer air, either complete stagnation or a positive downward flow will occur, usually the latter. Hence it is evident that much of the waste system will always be filled with dead air, moved only fitfully by the discharge of fixtures or changes of temperature, and this condition will be the more marked in large buildings where there are many rising lines of pipes. But, even when an upward air current does exist in the soil pipe, no movement of the air in the branches between the soil pipe and vent pipe will occur, from the fact that no provision is made to supply the increased volume of air necessary to establish and maintain such current."

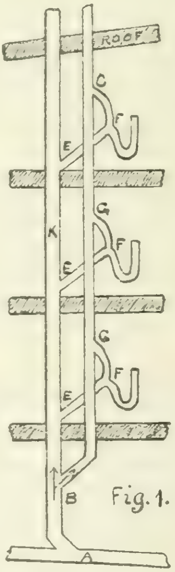


Fig. 1.

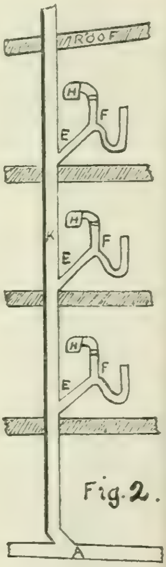


Fig. 2.

To further demonstrate the accuracy of these views the accompanying diagrams are used. Fig. 1 illustrates the usual system. "*A* represents the horizontal soil pipe or drain through which all the air must pass before it reaches the rising lines. If the vertical soil pipe *K* is 4 in. in diameter and the trap vent pipe 3 in., then 36 per cent. of the air is diverted at *B* into the vent pipe, where it ceases to perform any useful function. Hence it is obvious that the upper current and æration in the soil pipe above this point will be reduced more than one-third. At *E, E, E,* are three branches to which are attached traps, vented at *F, F, F,* into the vent pipe at *G, G, G,* in the usual way. As the rising current of air in the two pipes is necessarily equal in pressure, density, etc., and the capacity of the soil pipe is of uniform calibre to the top, it will require all its contained air to maintain an equal pressure and air current with that of the vent pipe; and, unless the vent pipe were enlarged above each branch, it would be incapable of receiving any of the soil pipe because such increase would destroy its equilibrium with that of the soil pipe.

"If the soil pipe were reduced in size at *E, E, E,* and the vent pipe correspondingly increased at *G, G, G,* then the amount of air proportioned to the changed capacities in the pipes would be diverted at each of the branches from the soil pipe at *E, E, E* to the vent pipe at *G, G, G;* but this would so reduce the upper portion of the soilpipe, as to render it incapable of performing its function. Thus the absurdity of the theory becomes self-evident.

"On the other hand, if each of the traps were vented automatically, as shown in Fig. 2, since the same amount of air must pass through the horizontal soil pipe in each instance and as none would be diverted from it at any point, the æration and air current would be 50 per cent. greater than in the corresponding soil pipe in Fig. 1. But the actual difference would be much greater than this, because every time there is a slight minus pressure in the pipe caused by the discharge of a fixture, or by a strong air current passing over the top of the soil pipe, large volumes of air would be drawn into the pipe through the automatic vents, and thus leave the branches filled with fresh air, which is impossible under the trap vent pipe system. Now let us suppose the horizontal soil pipe extended, and other rising lines attached; certainly very little circulation could be expected in any of these, for the simple reason that the first rising line would furnish capacity and the most direct route for the escape of the received air. Here again great advantage is secured by venting the traps automatically, since much fresh air is thus drawn into the pipes, while little or no circulation is possible under the trap vent pipe system. These facts show the advantage of this method over all others as a means of æration of the waste system, while the exhaustive researches in trap siphonage by Prof. James E. Denton, in the department of tests at the Stevens' Institute of Technology, demonstrate beyond question the practical superiority of a properly-constructed automatic device as a means that will preserve the trap seal against siphonage in the conditions occurring in plumbing practice."

Country Roads and Roadsides.

As a feature of landscape gardening, the treatment of country roads and roadsides is editorially considered in *Garden and Forest* (July 10) as meriting greater attention than has hitherto been bestowed upon it. Beyond the fact that a road should furnish good wheeling and footing, it may be made a delight by its borders. Through cultivated land borders of turf with suitable trees are recommended, but these borders should be kept trim and neat. In cases where the features of "the country are rugged and stony, undoubtedly the greatest beauty is secured if native shrubs and trees are allowed to take possession of the borders, and the axe is withheld unti they become too dense or aggressive."

As illustrating the possibilities for pleasurable effects in the treatment of by-roads, a bit of road, not more than a mile in length, is described in its summer aspect. "In the first place, it is not a highway of travel, and, therefore, it is only wide enough to allow two vehicles to pass. This is a distinct advantage. A broad road always has a depressing effect, and the wayfarer feels lonesome on it, as he does on any other desert. The more nearly a rural road is obliterated by its surroundings, the more delightful it is, and this is especially true of a by-road which offers a sense of seclusion as one of its principal charms. And, again, a narrow road can be more easily and cheaply kept in repair, since every additional square yard of surface requires so much more work, and this is an important matter in the community where the road-tax is a heavy item of expense. This particular road, after emerging from a piece of timber, climbs a hill, and then winds about some others until it drops into the rich bottom-lands of a small river and joins an important highway. On either side of it trees and shrubs in great variety take care of themselves; and in the first week of July, when the foliage has been washed clean by the rains, this border in its general effect was singularly beautiful. In some places there were thickets higher than a carriage-top, through which the eye could hardly penetrate; while just beyond were openings to give glimpses of a picturesque, rolling country, with a mountain range for a sky-line. The masses of foliage projected and retreated in the most natural way, without a single hard line or discordant color, now shrinking into deep shadows and again boldly courting the full sunlight, so that to one looking forward the disappearance of the road to right or left always seemed an invitation to prospects still more fair."

"The details of this border were quite as interesting as its general attractiveness. Here were elders in the beauty of their bloom, and white blackberry-blossoms close beside the red and black shining fruit of the raspberries. Close along the roadbed the clustered flowers of redroot were mingled with wild roses, and here and there among these native wildings was an occasional sweetbrier which had strayed from some old homestead. The buds of the smooth sumach, in their tall panicles, were just yellowing into bloom, while the pink fruit of the staghorn sumach was already appearing. The black alders were showing inconspicuous flowers among the dark green foliage, and at one point, where the ground was moist, a mass of white azaleas fairly glittered against the smooth clean leaves of the spice-bush. Thorns and cornels, choke-cherries and hazels and huckleberries, were in fruit, and the hardhack was just opening its closely-set rosy flowers. Along with the shrubs were young trees of various species struggling to assert themselves. There were little tulip-trees with foliage much larger than in mature specimens; oaks and maples of various species, with tints of foliage only seen in young individuals; ash and elm, and here and there a hornbeam, one of which, thrusting out its horizontal branches above some low-growing viburnums, was especially picturesque; hickories, butternuts, chestnuts, basswood, and sassafras; and over all these clambered the wild grape and moon-seed, smilax, bittersweet and clematis, with Virginia creeper festooning the fence-rows or hanging from the limbs of the trees which had here and there been allowed to reach natural size."

This graphic description will recall to many readers similar beauties in favorite drives and rambles. Of course, as the season moves, the variety of plants in bloom will change in character, but it is asserted that "there is not a day in the year when one who walks or drives over this short bit of road cannot find delight for his eye and food for his imagination." Many such bits of road could be made almost as effective as parks for places of pleasurable resort, and this could be done at a trifling cost, since the ground costs nothing for this special purpose.

Tests of Heat Insulation.

A RECENT experiment with three kinds of pipe coverings designed for preventing the escape of heat from steam and hot-water pipes, as in refrigerating machines, etc., is described in a recent number of the *Boston Journal of Commerce*. This experiment was made by a Cincinnati chemist, for the established purpose of determining comparative value of the coverings as insulating materials. The experiment is worth noticing, because, while it happens to be of the crudest possible sort, its results are being published in various journals as true indications of the relative value of these coverings, all of which are in use. Next to the duty of publishing the truth that of guarding the public against error should be respected by every technical journal. When an experimenter abandons well-known methods, generally accepted as reliable by the highest scientific authorities, for some new and untried method of his own, and, without any check upon the results, publishes them as authoritative, the inferences may be drawn that the results are unreliable, and that his experiments were performed with a view to establish a preconceived notion. It is, of course, possible that accurate results could be attained in this way; but the possibility of failure is so great that scientific people would not accept the results without verification, and common prudence would withhold them until corroborative proof of their accuracy could be obtained.

The experiments in question were performed as described further on. The old method of condensation, hitherto authoritatively regarded as the best known for determining loss of heat, is deliberately set aside, and results obtained by it, and by the same experimenter, are discarded in favor of the following method.

"A 2-in. pipe carrying steam at 60 lbs. pressure was selected, and a piece of covering 13 in. long placed upon it, and this covering inclosed in a box with a glass cover, and inside the box a thermometer was placed so that the temperature in this small box could be read. Three of these boxes were placed upon the pipe, 13 in. long, covered with the covering to be tested. The box having the lowest temperature was supposed to have the most efficient covering, on the supposition that the covering in that box prevented less heat passing from the pipe to the box."

The results are given, but we will not quote them, believing that in so doing we might do an unintentional injustice. Varying results are assigned as the reason for abandoning the old and tried way; but we notice that in the new method the results also varied, and that an average had to be struck. Those interested in the purchase and use of composition boiler coverings should be on their guard against accepting statements based on such crude tests, if, indeed, they ought to be called tests at all.

Heating by Gas.

THE results of practice in heating by gas in Germany are very instructive. A rather complete summary of these results is given in the *Sanitary Record* (August 2). From this summary it appears that the rapid extension of electric lighting in Germany has given an impulse to the employment of the existing plant, capital, and skill hitherto devoted to gas lighting in other directions and to the utilization of gas as a source of heat and power. The substitution of water gas for coal gas, which has been proposed on the ground of economy, has not given encouraging results, the heating power of hydrogen being so much lower than that of carbon; but there appears to be a remarkable difference among different samples of gas used for heating, not only from different towns, but from the same works at different hours of the day. These variations are altogether unaccounted for, and it would have been interesting if something had been said in our contemporary's summary upon this subject. The heat of combustion, given in heat units for the different ingredients of gas gives a total of 5241 heat units. "This total of 5241 heat units from 100 volumes of gas is attained only when the whole of the products of combustion escape into the room, which in practice is, of course, inadmissible; but the effective amount depends on the construction of the stoves, and may in some cases be as low as 29 per cent. of the whole."

This shows a remarkable deficiency in the appliances for the combustion of gas, more than two-thirds of the effect being wasted. However, in some of the better kinds of apparatus the efficiency is very much greater, ranging between 60 per cent. and 85 per cent. of the whole. Dr. Bueb of Dessau has determined the heat values of a number of gases by a Tunker's calorimeter, and, after deducting the loss by the condensation of the water vapor, he found the heating value of the gas of Dessau to be 4650 heat units, that of the gas of Erfurt to be 4850 heat units, the gas of Halle 5011 heat units, that of Leipsig 4797 heat units, that of Bremen 5434 heat units, and that of Frankfurt-on-Main 6700 heat units. These gases are all made from coal, and they may be considered as ordinary coal gases. In other kinds of gas very much greater divergencies were exhibited, thus: oil gas from Riebeck's works had a heat value of 9882 heat units; pure cannel gas at Bremen had a heat value of 5963; water gas made at Frankfort had a heat value of 2385 heat units. Dawson's gas had a value of 1312 heat units. It will be seen from these figures that the calorific value of various kinds of gas may vary through a range of from 1 to 9, taking the least value as a basis of comparison. The commercial success of gas heating depends on the cost of production, the heating power, and the amount of effective heat obtained in the particular stove used. It would, therefore, seem that gas of the smaller calorific value named in the last above-mentioned variety could under no circumstances prove to be a commercial success. For complete combustion eleven volumes of air for one volume of gas are needed, and this amount, mixed with the gas before burning, produces the blue "*Bunsen*" flame.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Heating and Ventilation.

90. Hot Water Heating in a Chicago Apartment House. Ill. (Descriptive of plant in a building 60x80 feet, and three stories above basement). Eng Rec–July 6. 1000 w.

240. The Union Depot at St. Louis. Ill. Serial. 1st part (Descriptive of heating and ventilation). Eng Rec–July 13. 1300 w.

285. "A Breezy Editorial." From the Architects Electrical Bulletin. Elec Rev–July 17. 800 w.

334. Heating and Ventilation of the Asylum for the Chronic Insane at Wernersville, Pa. Ill. (Descriptive). Heat & Ven–July 15. 2500 w.

335. Economy in Furnace Heating. William G. Snow (Coal saving and ventilation regulating with warm-air furnaces). Heat & Ven–July 15. 1300 w.

*671. Heating by Gas (Progress in Germany). San Rec–Aug. 2. 400 w.

Landscape Gardening.

103. Country Roads and Roadsides. Editorial. Gar & For–July 10. 1500 w.

187. Old-fashioned Gardens. Editorial (Their charm. Plants that used to be cultivated, etc.) Gar & For–July 17. 2000 w.

188. Midsummer Care of Chrysanthemums. T. D. Hatfield. Gar & For–July 17. 700 w.

189. Some Showy Perennials. R. Cameron. Gar & For–July 17. 800 w.

*317. Park and Garden Architecture. T. H. Mawson (Everything should be designed in harmony). Builder, Lond–July 13. 2400 w.

468. Japanese Vegetation in California. Charles Howard Shinn (Tendency toward extensive planting of Japanese trees, shrubs and flowers grows more and more evident). Gar & For–July 31. 1000 w.

Plumbing and Gas Fitting.

52. Some Fallacies of the Trap Vent Pipe System. Ill. J. W. Hughes (An attempt to prove that complete and continuous ventilation throughout every part of a waste system is impossible, or, at least impracticable). Arch & Build–July 6. 1100 w.

*135. The Apprenticeship Question (Speaks of the need of apprentices and of a movement to re-establish the old system in the plumbing trade). Plumb and Dec–July. 1400 w.

137. Country Plumbing. Ill. (In form of answer to a correspondent treats practically the plumbing of small country houses,—a subject on which practical literature is meagre. A useful article). Met Work–July 13. 1800 w.

257. Municipal Legislation. John L. E. Firmin (To what extent may municipal legislation be relied upon to enhance the standing of master plumbers? Is it not in some cases a bolster and endorsement of the unworthy?) San Plumb–July 15. 1300 w.

258. Unity. Edward D. Schuster (An argument against the bidding as sub-contractor by master plumbers. Such sub-letting is shown to be a great evil in the trade). San Plumb–July 15. 1400 w.

259. The National Association of Master Plumbers—Its Influence and Benefits. G. T. Ahrens (Read at 7th An. Con. of the Master Steam and Hot Water Fitters Asso. of the U. S.) San Plumb–July 15. 1600 w.

Miscellany.

†18. Gas-Contaminated Water (An account of contamination of water by gas in an 8-story business building, its cause and remedy). San–July. 400 w.

*228. The Products of Combustion of Coal Gas, from the Hygienic Point of View (An account of an investigation made by H. Chr. Geelmuyden in the laboratory of the Physiological Institute of the University of Christiana). Gas Wld–July 6. 3300 w.

*242. Disinfectors and Disinfectants, 1874–95: A Contrast. Ill. Joseph Priestly (Besides discussing the need and nature of disinfectants, describes a number of appliances and machines for disinfecting articles which have been exposed to contagion and septic influences). San Rec–July 5. 3400 w.

435. The Plumbers' School at Aue, Saxony (From a recent consular report). Arch & Build–July 27. 900 w.

*488. Special Report on a Case of Food Poisoning at Homerton. J. King-Warry (Poisoning of food attributed to emanations from foul drains). San Rec–July 19. 1100 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

Electric Power in Manufactories.

THE application of electricity as a means of distributing power in manufacturing establishments, in lieu of shafting, belting, and gearing, is beginning to attract attention to a degree somewhat commensurate with its importance. A recent paper on the subject by Messrs. Crocker, Bendikt, and Ormsbee, read at the Niagara meeting of the Electrical Engineers, is published in part in the *Electrical World* (July 13). Actual power tests made in several machine-shops and New England mills are given in considerable detail. These show that the average power consumed in the ordinary operation of certain machines is as follows: large boring machine, 1.43 h. p.; drill-press, 2.9 h. p.; small punch-press, 0.71 h. p.; group of one lathe and one milling machine, 1.47 to 2.28 h. p.; group of one small milling-machine, two 10-in. lathes, one grind-stone, one drill-press, one small punch-press, 0.86 h. p. In a group of seven lathes and one grindstone driven by a 3-h. p. motor, it was found that 1.14 h. p. was required to run one lathe, while four lathes could be run with 1.8 h. p.,—an increase of only 63 per cent. This result is due to the friction of the countershaft. A large planer, 120 in. between posts by 108 in. high by 22 ft. bed, took 4.76 h. p. on the cut, 5.73 h. p. on the return, and 21.6 h. p. on the reversal; average, 5.11 h. p. A cylinder-boring machine averaged 4.17 h. p. These results show that the actual power required to drive heavy machine-tools has heretofore been considerably over-estimated. In the case of the large planer, although the motor was overloaded 50 per cent. upon the reversal of the bed, the average load was only one-third the rated full load. The question whether machine tools should be driven individually by separate motors, or in groups, one motor driving each group, does not seem to admit of a general solution. Electric motors are very successfully used in calico-printing. The problem of running this class of machinery has proved a very difficult one, inasmuch as the motor must be capable of running at a number of different speeds and running constantly at any given speed with a variable load. It is claimed that in this class of work the increase in production with the electric motors amounted to more than 25 per cent., while the quantity of inferior product was at the same time considerably reduced. This is a very important matter, as the men in charge of printing machines are skilled workmen of a high order, and a small saving in wages for a given production is of more value than a considerable saving in power.

Underground Wires in Boston.

IN the *Electrical World* (July 20) Mr. J. E. Talbot has an excellent article, giving full particulars of the condition, progress, and prospects of the work now going on in Boston in the way of placing the electric lines underground in the central portions of the city. Although the work here did not begin under legal compulsion until 1894, this delay served a good purpose, as it enabled Boston to avoid many costly mistakes which were unavoidable in New York and Chicago, in which cities those who undertook somewhat hastily to do the work found that they had much to learn. From September, 1894, to February, 1895, 400,000 ft. of duct were laid. The telephone companies alone have now over 11,000 miles of underground wire in Boston, much of which had been laid before the compulsory legislation of 1894 went into effect. The total amount of duct in the city, according to the latest report of the commissioner, is over 2,000,000 ft., in which are laid 1,817,000 ft. of cable, about one-third of which is used for telegraphic and telephonic service. The conduits are not, as in New York, owned by the municipality, but are built and owned by the operating companies under the supervision of a municipal officer, subject to an appeal to a board consisting of the city engineer, the superintendent of streets, and the chairman of the board of fire commissioners. In many cases, by joint agreement, several electric companies occupy the same trench, in order to avoid unnecessary opening of streets. The inevitable cost has not been increased by needlessly harsh or heroic measures. The commissioner has carried out the provisions of the law with tact, discretion, and courtesy, and the representatives of the various electrical companies have never acted in an obstructive or unwilling manner. This, unfortunately, has not been the case in many other cities which might be mentioned.

Electric vs. Steam Locomotives.

AN editorial on this subject in *The Street Railway Journal* for July expresses the belief that the substitution of electric for steam locomotives on trunk lines is not a near probability. The question of such substitution is, however, under active discussion, and the sensational accounts of trials of electric locomotives and their remarkable performance has led an over-sanguine public to believe that we are on the very eve of such a revolution. The editorial quoted expresses the view that this resolution " is far in the distance, and not likely to come about in this generation, at least. Such a road as the New York Central between New York and Buffalo is, of course, much nearer the electric age than roads like the Northern Pacific, the Union Pacific, or even the roads between Chicago and St. Louis, because, for its entire distance, it passes through one of the most populous sections in the country,—an unbroken chain of large cities 2 hours apart, of smaller cities at regular intervals in between, and of other townships and settlements of various sizes hardly 10 minutes apart. But power stations cannot profitably be established at intervals of 10, 20, or even 50 miles to serve only four or five trains an hour. There must be practically continuous traffic for from 15 to 20 hours a day, if the full advantages of the generation and distribution of power on the central station plan are to be realized; for it must be remembered that our steam locomotives are, on the whole, highly efficient machines, and cannot be replaced by electric locomotives for the same service without the very closest figuring of costs, and until a certain magnitude is reached in the scale of operations. In other words, this entire problem of the adaptation of electricity to the larger field of railway work is dependent almost entirely upon the magnitude of traffic possible to be obtained, not upon relative economies in operation."

Telegraphic Line Construction.

AT a recent convention of railroad telegraph superintendents in Montreal, W. F. Taylor of the Pennsylvania Railroad read an excellent paper on the construction of telegraph lines, which is printed in abstract in the *Railroad Gazette* (July 5) It certainly seems amazing that so little real progress has been made during the last quarter of a century in this most important branch of electrical engineering. Mr. Taylor, however, seems to have touched upon most of the really essential points in line construction. Poles, he says, should never be less than 22 in. in circumference at the top, or be set less than 5 ft. in the ground. The tendency to use unduly high poles was deprecated; the shortest possible poles should always be used. The lower wire need not be over 10 ft. from the ground along the railroad location, except at highway crossings, where it should be raised to 22 ft. or more. At each end of curves exceeding three degrees, two or three poles should be well guyed or braced, and on long tangents every tenth pole should be head-guyed. More attention should be paid to the matter of double-pole construction. No. 8 iron wire, the size ordinarily used, should not be strained over 200 lbs.; the usual practice is to strain it to nearly twice that amount, which leaves a very small factor of safety. Tests show the strength of an unsoldered twist-joint to be only 55 per cent. of that of the solid wire, while a soldered joint of the same type has an excess of strength. In the discussion which followed the paper, much stress was laid on the fact that the railroad managers did not pay the attention they should to the requirements of good telegraphic construction. The suggestion was made that in places much exposed to the effect of storms a line will stand better if built in an unsymmetrical manner, so as to eliminate the effects of harmonic vibrations produced by the action of the wind upon the wires.

Street-Railway Financiering.

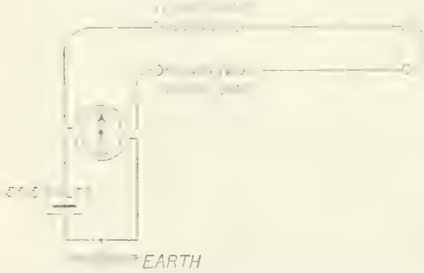
A SPECIAL issue of the *Street Railway Journal* (July) contains what is apparently a complete summary (reproduced in our department of railroading) of the statistics of the street railways of the United States. There are 976 roads with a total mileage of 13,588, of which 10,363 are operated by electricity, 1914 by animal power, 632 by cable, and 679 by other motors. The number of cars is 44,745. The aggregate capital stock is $748,014,206, and the funded debt $552,125,505. Thus the aggregate liabilities per mile, of all the roads, reaches the enormous sum of $95,600. These figures make it plain to a demonstration, that the majority of the street-railway building of the past few years has been the work of professional speculators. Nothing can be more certain than that there must come, within a short time, a severe financial crisis in this species of property. One of the most thoroughly constructed, complete, and profitable street-railway systems within our knowledge is capitalized at only $30,000 of stock and bonds per mile of track. In 1893 the average capitalization of all the steam railroads of the United States per track mile was $28,513 in stock and $31,119 in bonds,—a total of $59,632. A recent article in *Electricity* (June 12) illustrates the methods of the street-railway boomers by giving facts and figures of a typical example. It appears from this article that in 1890 a certain thriving municipality, having a population of 36,000, rejoiced in the possession of a system of horse railways capitalized at $250,000. Certain promoters, apparently not unconnected with a prominent electrical manufacturing company, took hold of the system, equipped it with electricity, capitalized it at $750,000, and issued $750,000 bonds on top of that. Then, by the aid of a new set of promoters, a consolidation was effected with another line extending 10 miles through a wilderness to a hamlet of perhaps five hundred inhabitants, on which $491,000 of bonds had been issued, although the total gross earnings of the line thus absorbed were less than one-third of the interest on the bonds. Bonds amounting to $1,500,000 were issued on the consolidated property, $1,250,000 of which are said to have been disposed of to "investors." Therefore the total liabilities of the consolidated concern up to date are apparently at least $2,250,000, which is certainly quite enough for a town of thirty-six thousand inhabitants. There is every reason to believe that this scheme, or some similar one, has been worked to a greater or less extent in a great many other places in the United States; and, when the defrauded bondholders wake up, as they will in time, there is likely to be a considerable uproar.

Trolley-Wires and Lightning.

IN a communication to the *Electrical Engineer* (July 21) D. B. Grandy, a well-known electrician of St. Louis, calls attention to the fact that in the summer of 1894, and even to a greater extent during the present summer, the switchboard of the central telegraph office in that city has been entirely free from electrical disturbances, in marked contrast to preceding years, when the blowing of fuses and the burning of instruments were matters of very frequent occurrence. He states that within a few miles of the city the electrical storms have been more frequent and more destructive the present year than ordinarily. He suggests that the extension of trolley-wires throughout the city during the past 2 years may explain the phenomenon. There can be little doubt that such is the case. It would be difficult to contrive a more effective means of equalizing excessive electric tension between the air and the earth, which is the accepted cause of electrical disturbances, than a network of suspended trolley wires, grounded not only at each end, but through every car in transit upon the route. So effective is this protection that a seat in a trolley-car is probably the very safest place in the world during a thunderstorm. Nor is it worth while to jump overboard in case the lightning blows out a fuse and creates an explosion, as the passengers did one day in an open car in Boston; if one has time to jump, the danger, if there was any, has passed away.

Testing Telegraphic Circuits.

In a widely-extended telegraphic system the maintenance of a perfect service demands that every line shall be tested each day before the opening of business, especially with reference to its condition of insulation, technically known as "insulation resistance." Heretofore this has usually been done by sending a current of known potential from the testing station over each wire in succession, and registering the effect of such current at the distant station upon a tangent galvanometer of carefully-estimated sensitiveness. This method is not free from liability to considerable error, but has the advantage of being very expeditiously applied. In the *Journal* of the Institution of Electrical Engineers (London, July,) Mr. W. H. Preece describes a new method of making such tests, devised by Mr. A. Eden of the post office and recently adopted in the British government service, which appears to present important advantages over the old method. At the head office a carefully-determined electromotive force of 55.5 volts is employed in conjunction with a differentially-wound tangent galvanometer. The positive pole of the testing battery is grounded, and the testing current is transmitted from the negative pole through one coil of the galvanometer and a resistance of 10,000 ohms, out to the distant station and back through the two wires looped together at that point (see figure) returning through a second resistance of 10,000 ohms and the other coil of the galvanometer to earth. If the insulation were perfect, the currents through the opposing coils of the galvanometer would be equal, and the needle would stand at zero; while any difference between the outgoing and returning currents, due to loss through defective insulation on the line, must be exactly indicated by a corresponding deflection, the mean value of insulation resistance corresponding to each angle of deflection being given in a set of tables. Any abnormal leakage is thus detected, and the precise locality of the fault may be found by at once applying the ordinary "bridge test," for which the circuits are already properly connected. It may even be estimated with sufficient accuracy for practical purposes by the original apparatus, by removing the 10,000-ohm resistances, observing the direction and extent of the deflection upon the differential galvanometer, and applying the well-known loop formula to the result. The importance of maintaining a high standard of insulation is far more important where high-speed systems of transmission, like the Wheatstone automatic, are used, and hence the British post office has now adopted for such lines a minimum standard of one megohm per mile of insulation resistance.



Electric Plant at the Baltimore Tunnel.

A CAREFULLY-WRITTEN and well-illustrated description of the electric locomotives and plant of the new Belt-line tunnel in Baltimore is given in the *Electrical Engineer* (July 10). From this we learn that the power-plant consists of four 500-k. w. direct coupled generators, of the iron-clad armature type, compounded so as to give 600 volts at no load and 700 volts at full load. The working conductor has a cross-section equivalent to 1,000,000 circular mils. The distance over which the electric traction operates is about 15,000 ft., the length of the tunnel proper being 7339 ft. The electric locomotive, though to ordinary eyes a far less handsome machine than the modern steam locomotive, is, as the photographic illustration shows, by no means the ungainly monster that some of the accounts hitherto published might lead one to believe. It has two trucks, each fitted with two driving-axles and two electric motors. The weight on the eight drivers is 96 tons, and the ordinary drawbar-pull 42,000 lbs., which is capable of increase at starting to 60,000 lbs. The four motors are flexibly supported, and have each six poles and six sets of carbon brushes, four of which may be removed in emergency, without disabling the motor. Each motor is rated at 360 h. p., and takes a normal current of 900 amperes. The working conductors are placed overhead, and consist of two 3-in. iron Z-bars each, which are riveted to a cover plate so as to form a sort of reversed iron trough, within which slides the contact-shoe attached to the locomotive. This is of brass, and is mounted upon a jointed parallelogram of rigid bars affixed to the top of the cab, the whole system being capable of lateral deflection to allow for inequalities in the alignment of the track or working conductors. Some little trouble was encountered in the working of this apparatus during the preliminary experiments, but this appears to have been overcome, and, according to the latest advices, the performance of the apparatus is altogether satisfactory.

An Elementary Science Lesson.

WE regret to observe that the technical matter which appears in the columns of our esteemed contemporaries devoted to the advancement of electrical science is not always edited with the conscientious intelligence that could be wished. For example, one of these journals, whose name we refrain from mentioning, gave some time since an illustrated account of a newly-invented primary battery,—a fruitful subject of "invention" on the part of half-fledged scientists for at least two generations. After remarking that "attempts at increasing the output of batteries have been in the past devoted almost exclusively to increasing the ampere capacity to the practical neglect of the quest for increasing the voltage," the writer of the article goes on to say that he has had an opportunity of inspecting and testing the new cell, and in consequence of such inspection and test he ventures the opinion that it embodies a "genuine advance in battery work." The delightful absurdity of this solemn asseveration will be apparent, when it is stated that the alleged improvement consists in placing three pairs of zincs and carbons in a single cell, these being connected in series and all immersed in one and the same body of liquid. Considerable correspondence in the way of discussion, pro and con, of the "theory" of this valuable organization has been printed, which, like the sea-serpent stories of the daily press, may serve to enliven matters during the dull season; but in the *Electrical Engineer* of July 10 Professor W. A. Anthony ruthlessly analyses the action of the cell, and shows that the only possible advantage of the arrangement is the facility of handling a gallon or two of solution in one vessel instead of three, while, on the other hand, if the cell is used with any regard to efficiency, the internal leakage or waste current must necessarily be equal to the useful current, and hence the consumption of material must ordinarily be about double that of the ordinary cell. It is certainly to be regretted that people should be misled, as they often are, into wasting effort and money in the promotion of "inventions" of this type, by reason of a quasi-endorsement in the columns of presumably trustworthy technical journals.

Electricity in the Blacksmith's Shop.

ONE by one, in this age of steam and electricity, the picturesque features of the old-time industries are passing away forever. A recent number of the *Electrical Engineer* (July 17) gives a well-executed photographic reproduction of the interior of a typical rural blacksmith's shop. In the foreground may be seen the anvil and the tub in which the hot irons are cooled, while in the shadows of the background we discern the forge with its chimney and bellows,—the former, alas! serving now apparently only as a convenient place of deposit for old iron and other litter usually found about such establishments, and the latter evidently covered with dust and cobwebs. A moment's inspection discloses to the eye of the initiated that here too electricity has been getting in its iconoclastic work. A rough board nailed to the disused chimney supports a piece of mechanism which we recognize as a double-pole electric switch, and from this insulated wires extend to a rectangular wooden tank standing on four legs near the anvil, looking not unlike a horse trough, which, the text informs us, is filled with an aqueous solution of washing-soda and borax, and constitutes the modern substitute for the forge fire hitherto assumed (but erroneously, as it now appears) by the Tubal-Cain and his worthy successors to be one of the essentials of an iron-worker's outfit. All that is necessary, we are informed, is to attach one of the circuit-wires to the clamp which grasps the piece of iron to be heated, thrust the latter into the solution, and turn on the current. Electrolysis at once takes place all over the surface of the metal in contact with the surface of the solution, and hydrogen gas is disengaged and takes fire, imparting its heat to the metal and quickly bringing it to any required temperature. The photograph illustrates a horse-shoeing establishment at Niagara Falls, the liquid forge deriving its operating current from a dynamo driven by the water of the Niagara river. With electric current costing 15 cts. per k. w. hour, the cost of preparing a horseshoe by this process is found to be 2.32 cts. as against 5.58 cents with coal at $5 per ton, while the absence of scale or oxid is said to effect a material improvement in the quality of the product.

SOME important considerations relative to street-lighting were presented by Mr. George Cutter in a paper read before the Northwestern Electrical Association, given in the *Electrical Engineer* (July 31). Mr. Cutter thinks that a general uniform illumination of mild intensity, like that of a dark cloudy day or of a clear night with a moon, is the theoretical condition which it is desirable to artificially reproduce. This condition may be secured most economically and effectively by the installation of incandescent lamps, but Mr. Cutter advises, in addition, the employment of arc lights in the business portions of a town, which, after the business places are closed, may with advantage be replaced by a moderate illumination of the same character as that in the residence districts. The more the subject is studied by experts, the greater seems to be the appreciation of the advantages of the incandescent lamp for municipal lighting.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

68. Notes on the Reconstruction of a Small Central Station Plant. Consolidation of three different plants, and change from steam to water power. Franklin L. Pope (Paper read before the A. I. E. E., Niagara Falls, June, 1895). Elec Rev–July 10. 7500 w.

181. The Time System of the Toronto Electric Light Company. Ill. (Describes and illustrates an apparatus and method whereby time indications may be accurately transmitted from a master clock in a central station). Can Elec News–July. 1700 w.

*202. Electric Lighting in the Far East.—An Alternating Station at Hong-Kong. Ill. (Descriptive). Elec Plant–July. 1300 w.

263. Lighting Mills with the Inverted Arc Lamp. From letter by D. L. Goff (Desricbes plant at Pawtucket, R. I. Economics). Ir Age–July 18. 1800 w.

*291. Arrangement of an Electric Lighting Plant. Ill. Francis B. Crocker. Elec-Pow–July. 1600 w.

*320 An Example of Interior Conduit Wiring. (Designed for Messrs. Heclas, Sons and Co. of Reading) Albion T. Snell. Elect'n–July 12. 1000 w.

495. The Use of the Alternating Current for Lighting Gedney's Channel, New York Harbor. Ill. (Descriptive). Elec Eng–July 31. 800 w.

571. Economics in Small Central Stations. W. M. Stine (Less intelligence in the installation and operation of small plants. Arguments supporting this conclusion). W Elec–Aug. 3. 1100 w.

*607. Tests of Glow-Lamps. W. E. Ayrton

and E. A. Medley (Physical experiments). Ind & Ir–July 26. Serial. 1st part. 4000 w.

Power.

51. Electric Power in Factories and Mills. F. B. Crocker, V. M. Benedikt and A. F. Ormsbee (A paper read at the meeting of Am. Inst. of Elec. Eng., Niagara Falls, June 26, 1895). Elec–July 3. Serial. 1st part. 2500 w.

66. Compounding Dynamos for Armature Reaction. Ill. Elihu Thomson (Read before A. I. E. E., Niagara Falls, June, 1895.) Elec Rev–July 10. 2600 w.

108. Electric Locomotives on the Baltimore and Ohio Railroad. Ill. (Descriptive). W Elec–July 13. 3200 w.

*152. Early History of Electric Traction. I. William Chubb (The first electric locomotlve is attributed to Thomas Davenport, Brandon, Vt., 1835). Prac Eng–July 5. 3000 w.

*153. Test of a Field's Combined Steam and Hot Air Engine. Andrew Jamieson, with editorial (Account of results of a test, wherein from a single cylinder, non-condensing engine, I. H. P. per hour was obtained with a consumption of 18.6 lbs. of water). Prac Eng–July 5. 1500 w.

*203. Action of a Single Phase Synchronous Motor. Ill. Frederick Bedell and Harris J. Ryan (A study of the synchronous motor with particular reference to phase relations of the different variable quantities in any alternate current problem). Elec Plant–July. Serial. 1st part. 2400 w.

*204. Two-Phase Plant at the Pantin Works of M M. Weyher et Richemond. Ill. (Descriptive). Elect'n–July 5. 1100 w.

*205. Hysteresis, Frictional and Eddy-Current Losses in Continuous-Current Dynamos. George Adams (Describes Mr. Gisbert Kapp's graphic method of determination). Elect'n-July 5. 600 w.

*212. The I. E. S. Storage Battery for Lighting and Traction. Anthony G. New (Existing forms of accumulator plates and description of the I. E. S.). Elec Rev, Lond–July 5. 1600 w.

275. The Burton Liquid Electric Forge. Ill. W. W. Ker. (Descriptive). Elec Eng–July 17. 800 w.

277. Electric Freight Haulage. Editorial (A prediction that the trolley is about to cut deeply into the freight traffic of steam railways). Elec Eng–July 17. 700 w.

280. An Electric Traveling Crane for Carrying Baggage. Ill. (Descriptive of plant at Victoria Station, Manchester, England). Elec Rev–July 13. 250 w.

*294. The Utilization of Water Power in Connection with Electric Power Plant. Ill. Charles Simon Herzig. Elec Pow–July. 5500 w.

*328. Some Practical Hints in Dynamo Design. Gilbert Wilkes (From the Bulletin of the University of Wisconsin). Elec Eng, Lond–July 12. 5000 w.

344. Electric Welding for Repairs. Editorial (Convenience ; possibilities). Ry Rev–July 20. 800 w.

373. Canadian Water Power Schemes at Niagara, Montreal and Toronto. Ill. Elec Eng–July 24. 1200 w.

382. The Maximum Possible Efficiency of Galvanic Batteries. Henry Morton in Cassier's Mag. Sci Am Sup–July 27. 1000 w.

383. Long Distance Electric Power Transmission (Sacramento. Distance, 24 miles). Am Mach–July 25. 150 w.

399. Multiple Current Dynamos. Rankin Kennedy (Description of his own design). Elec–July 24. 1100 w.

400. Electric Traction by Accumulators. J. Sarcia. From "The Bulletin de la Société Internationale des Electriciens." Elec–July 24. 1800 w.

431. Economy of Conductors Used in Transmission of Current for Electric Railways (A summary of address by Edward P. Burch. Feeder Plan in service in Minneapolis and St. Paul. Called a jumper system. Its advantages). Elec Ry Gaz–July 27. 1800 w.

*465. Electrical Transmission of Power, with Special Reference to Mining Operations. H. T. Haws (Transmission over distances measured by the mile). Elect'n–July 19. 4000 w.

474. Distinguished Scientists in Acrid Discussion (Professors Rowland and Forbes write about the Niagara Question). Elec Rev–July 31. 2000 w.

475. Central Station Economics (Read before the Northwestern Elec Asso., Chicago, by J. S. Stephens). Elec Rev–July 31, 2000 w.

511. The Chicago Metropolitan West Side Electric Elevated R. R. Station. Ill. (Descriptive). Power–Aug. 1000 w.

512. Dynamos. Ill. First Aid to the Injured. Arthur M. Lozier (For the benefit of engineers who have in their charge either dynamos or motors). Power–Aug. Serial. 1st part. 2500 w.

†538. Electrical Construction on the Mount Holly Branch of the Pennsylvania Railroad. Ill. (Plant ; installation.) St Ry Jour–Aug. 1300 w.

†539. The Electric Conduit of the Metropolitan Railroad (Washington, D. C.) and the Reasons for Its Adoption. Ill. A. N. Connet (Sections of conduit ; insulation ; drainage). St Ry Jour–Aug. 1400 w.

†540. Electric Conduit for the Third Avenue Railway Company, New York. Ill. (Sections ; joints ; trolleys ; hand holes). St Ry Jour–Aug. 800 w.

†546. Test of an Electric Railway. Ill. A. Langstaff Johnston (Ammeter and voltmeter tests on grades and curves). Jour Fr Inst–Aug. 1000 w.

570. Electric Power (Record of some tests of machine tools). Bos Jour Com–Aug. 3. 1700 w.

*593. On the Investigation and Design of Alternate Current Dynamos. H. Behn-Eschemburg (A convenient method which furnishes direct values, and which permits of the comparison and discussion of alternators). Elect'n—July 26. 2000 w.

*628. Producer Gas Motors and Electrical Power Transmission (A remarkable application of electrical driving of machinery in the chemical manure works of M. Paul Linet, at Aubervilliers). Elec Rev, Lond–July 26. 1800 w.

629. The Belt as Applied to Electrical Apparatus. A. W. Foster (The article is confined to belts used with electrical machinery, but many of the facts mentioned are applicable to all belting wherever used). Elec Ind–Aug. 900 w.

645. A Ninety-six Ton Electric Locomotive. Ill. (The engine of the Baltimore & Ohio R. R.). Sci Am–Aug. 10. 1400 w.

Telephony and Telegraphy.

50. Independent Telephone Men Combine (The Telephone Protective Association formally organized). Elec–July 3. 900 w.

276. The Longest Telegraph Circuit in the World (In Australia; length 7246 miles). Elec Eng–July 17. 300 w.

279. Marshall Duplex Telephone System. Ill. (Descriptive). Elec Eng–July 17. 400 w.

281. Setting Type by Sound (An interesting experiment with the telegraph and the linotype. Reports can be taken from the wire and put into type by the receiving operator with great ease, speed and satisfaction). Elec Rev–July 17. 600 w.

282. The Parliamentary Telephone Inquiry in England. With Editorial (A résumé of evidence given before the committee). Elec Rev–July 17. 2500 w.

284. The Callender Automatic Telephone Exchange System. Ill. (Descriptive). Elec Rev–July 17. 350 w.

288. The Invention of the Electromagnetic Telegraph. Ill. (Facts bearing on the credit due respectively to Joseph Henry, S. F. B. Morse and Alfred Vail. Articles by Francis W. Jones, Franklin L. Pope, J. J. Fahie, Postrath Petsch, and A. M. Tanner). Elec Wld–July 20. Serial. 1st part. 3700 w.

290. Neglected Evidence in the Berliner Case. E. F. Frost (Concludes that the Berliner patent of 1891 was unwarrantably issued). Elec Wld–July 20. 3500 w.

*314. An Electric Telegraph in the Middle of Last Century. Ill. Charles R. Gibson (Historical and descriptive). Elec, Lond–July 12. 1400 w.

315. Storage Batteries for Telegraph Work. Maurice Barnett (Economical substitute. Will displace gravity cells where a changing current is available). W Elec–July 20. 2000 w.

374. Repairing Underground Telegraph Cables in West Africa. Ill. (A unique engineering experience). Elec Eng–July 24. 1800 w.

†567. The Telegraph in England. Walter Clark (Consideration of facts published in the official report of the government telegraph in England). Arena–Aug. 1500 w.

Miscellany.

53. Electricity at the Mining Exposition, Santiago, Chili. Ill. Harry Bindermann (Description of exhibits). Elec Eng–July 3. 1400 w.

60. Residual Charges of Condensers. A. S. Dunstan (Describes experiments with residual charges in condensers with mica dielectric). Elec Wld–July 6. 1600 w.

63. The Electrical Plant of the New State House of Massachusetts. Ill. W. L. Key (Details and descriptions). Elec Eng–July 10. 2400 w.

64. Some Features of Alternating Current Systems. Charles Proteus Steinmetz (Abstract of paper read before A. I. E. E., Niagara Falls, June, 1895). Elec Eng–July 10. 2000 w.

67. The Cause of Death in Electric Shock. A. M. Bleile (Experiments and data. Paper read at A. I. E. E., Niagara Falls, June, 1895). Elec Rev–July 10. 2200 w.

101. Advantages of the Dry Battery (Special fitness for open circuit work; little deterioration when not in use). Ir Age–July 11. 1200 w.

106. The Sensibility of Galvanometers. W. M. Stine (Attention called to the proper rating of astatic and non-astatic galvanometers). Elec Wld–July 13. 1600 w.

107. On Certain Effects Produced by "Distributed Capacity" in Wire Coils. A. S. Kimball (Experiments and remarks). Elec Wld–July 13. 2200 w.

*177. Some Uses of Curves in Electrical Practice. H. H. Simmons, with Editorial (Instruction in the use of curves in representation of physical facts, and analysis of curves so used. The writing and reading of curves). Elec Eng, Lond–July 5. Serial. 1st part. 1800 w.

*206. Arnoux-Chauvin Voltmeters and Ammeters. Ill. (Description of these new instruments). Elect'n–July 5. 900 w.

*207. Wave Form Synthesis. James Mark Barr (Describes the use of the electronometer or galvanometer and the tracing out of any Fourier function with a light spot on a moving photographic plate). Elect'n–July 5. 500 w.

*209. Experiments on the Relation of Hysteresis to Temperature. Frank A. Laws and Henry E. Warren (An account of some experiments to determine the effect of temperatures much above the normal on the dissipation of energy by hysteresis in a specimen of steel). Elec Rev, Lond–July 5. Serial. 1st part. 1200 w.

*210. The Electrical Standardizing Testing and Training Institution. Ill. (Descriptive of methods and apparatus used in this institution). Elec Rev, Lond–July 5. 1000 w.

283. Location of Grounds in Armatures, Fields, etc. Ill. Clarence E. Gifford. Read before Am. Inst. of Elec. Eng. at Niagara Falls (Descriptive of methods devised by the author). Elec Rev–July 17. 2500 w.

286. Long Distance Transmission at Ten Thousand Volts. The Pomona Plant. George Herbert Winslow. Read before the Am. Inst.

of Elec. Eng. at Niagara Falls (Descriptive of the plant of the San Antonio Light and Power Co. at Pomona, Cal). Elec Rev–July 17. Serial. 1st part. 4000 w.

289. Underground Wires in Boston. Ill. J. E. Talbot (Nature and extent of the undertaking). Elec Wld–July 20. 3300 w.

*293. Technical Instruments for Measuring Electrical Current Strength, Electrical Pressure and Electric Power. Ill. Alfred E. Wiener (A treatise for practical rather than scientific readers). Elec Pow–July. Serial. 1st part. 3000 w.

*322. Thermo-Electric Powers of Metals and Alloys Between the Temperatures of the Boiling-Point of Water and the Boiling-Point of Liquid Air. James Dewar and J. A. Fleming (Abstract of a communication made to the Phil. Mag. of July). Ill. Elect'n–July 12. 4500 w.

*323. Armature Cross Turns in Continuous Current Dynamos and Their Effects. Ill. George Adams. Elec Rev, Lond–July 12. Serial. 1st part. 500 w.

*327. On a Method of Determining the Thermal Conductivity of Metals, with Applications to Copper, Silver, Gold and Platinum. Ill. James H. Gray (Method suggested by Lord Kelvin. Advantages claimed : (1) It is simpler. (2) Test can be made in two or three hours. (3) Only a few grammes of the metal are necessary). Elec Eng, Lond–July 12. Serial. 1st part. 2700 w.

339. Economical Design of Electric Light and Power Plants. George W. Blodgett (Methods suggested and discussed). R R Gaz–July 19. 1600 w.

†369. Discussion on paper by H. Ward Leonard—"Notes on Recent Electrical Engineering Development in France and England." Trans Am Inst Elec Eng–May. 2100 w.

†370. Discussion of paper by Harris J. Ryan and Milton E. Thompson—"A Method for Preventing Armature Reaction." Trans Am Inst Elec Eng–May. 2600 w.

†371. Discussion on paper by A. E. Kennelly—"Resonance in Alternating Current Lines." Trans Am Inst Elec Eng–May. 5000 w.

†372. Discussion of paper by Prof. Anthony —"Underwriters' Rules." Trans Am Inst Elec Eng-May. 18900 w.

375. The Inductance of the Di-electric. John S. Stone (Explanatory remarks on meaning of the term). Elec Rev–July 24. 1300 w.

401. Indirect Electrolysis. E. Andreoli. Translated from "Le Génie Civil" (Explanation). Elec–July 24. 1500 w.

416. General Electric and Its Schenectady Plant (Advisability of removing the plant). Elec Wld–July 27. 1200 w.

417. The Monocyclic System. Ill. (Explanation of the system by C. P. Steinmetz). Elec Wld–July 27. 500 w.

*461. The Valency of Mercury and Copper in Certain Electrolytes (Extracts of special interest from paper by Dr. Werner Bolton, published in the Zeitschrift für Electrochemie). Elect'n July 19. 1400 w.

*462. Observations on the Holtz Theory of Influence Machines with Oppositely Rotating Discs. James Wimshurst. Elect'n–July 19. 2000 w.

*463. Theory of the Influence Machine with Oppositely Rotating Discs. Ill. W. Holtz (Complete account of theory and of various forms which may be given to the machine). Elect'n–July 19. 2400 w.

*464. On the Theory of the Wimshurst Machine. Ill. V. Schaffers. From the Annales de Chimie et de Physique. Elect'n–July 19. 2500 w.

*491. The Design of Transformers. George Adams (Transformers having a closed magnetic circuit, and to be connected in parallel on constant potential mains). Elec Rev, Lond–July 19. Serial. 1st part. 1200 w.

*492. Electrical Engineering Education. Ill. William A. Anthony (The facilities offered at Cornell Univ. with general remarks). Elec Pow–Aug. 2500 w.

*493. Electro-Deposition of Brass. Frank Sutton (The object of the article is more on a theoretical basis than a practical one, but really includes both). Elec Pow–Aug. 2000 w.

*494. The Counter Electro-motive Force in the Electric Arc. W. H. Freedman (Experimental investigations). Elec Pow–Aug. 2400 w.

496. English Internationalism. E. Hospitalier in L'Industrie Electrique (The services it can render to the cause of uniformity of symbols, notation and physical units). Elec Wld–Aug. 3. 1400 w.

†518. Electric Heating. J. Chester Wilson (Various applications ; conveniences ; discussion). Pro Eng Club of Phila–July. 4200 w.

†527. On the Velocity of Electric Waves. Ill. John Trowbridge and William Duane (Experimental results). Am Jour of Sci–Aug. 2000 w.

*588. The Factory Testing of Vulcanized India-Rubber Covered Cables and Wires. Ill. J. Warren. Elec, Lond–July 19. Serial. 1st part. 1000 w.

*594. Shipboard Galvanometers. J. Rymer-Jones (Tests of the Weatherall & Clark damping device as applied to the Thomson marine galvanometer, and the Sullivan "Universal"). Elect'n–July 26. 1100 w.

*595. New Method of Measuring Electric Capacities, Based on the Sensitiveness of the Skin. H. Bordier. Elec Eng, Lond–July 26. 800 w.

623. The Relations between Pressure, Electrical Resistance and Friction in Brush Contact. Ill. E. V. Cox and H. W. Buck (Investigation undertaken with the object of furnishing some accurate data on the subject). Elec Eng–Aug. 7. 1200 w.

624. My Experience with Interior Work. A. E. Dobbs (Wiring). Elec Eng–Aug. 7. 2000 w.

627. Electrical Interference. Arthur Vaughn Abbott (Read before the Northwestern Electrical Association, Chicago). Elec Rev–Aug. 7. Serial. 1st part. 900 w.

INDUSTRIAL SOCIOLOGY

The Twentieth Century.

In an address delivered before the graduating class of the Yale Law School Justice Henry B. Brown, of the United States supreme court (*Forum*, August), rapidly reviews the enormous industrial and commercial changes that have marked the present century, and makes a forecast of what the twentieth century is likely to bring about. The primary effects of the numerous and astonishing inventions to which the century has given birth, important as they are, even beyond estimation, he regards as of much less economic importance than the "secondary effects which have become apparent within the past 30 years, and which threaten, not only to affect the political future of every State, but to revolutionize the entire productive industry of the world. It is a change which began silently, has progressed furtively, but relentlessly, and is yet only at the threshold of its tremendous possibilities. So unforeseen was it that it may be said to have stolen upon us like a thief in the night. It may be summed up in the single word 'consolidation,'—consolidation in politics, in business, in society. This influence is everywhere the same: the centralization of power in the hands of a few; the unification of people of kindred race and similar language; and, in this country, a vast accession to the power of the federal government. Wise men may differ as to whether the liberties of the people can better be preserved in large States or in small ones. History doubtless favors the latter, but the historical republics had neither steam or electricity, or the general diffusion of education and intelligence they have brought in their train. In producing the evil—if it be an evil—they have also furnished the antidote. The nineteenth century has given birth to large States, but at the same time has curtailed the privileges of the great, has expanded the area of freedom, and entrenched the people in their natural rights. But these speculations are of little value. The large States are upon us and overshadow us. They have come to stay, and, for better or for worse, the world must adapt itself to their conditions." The same influence pervading industry has "revolutionized the whole system of production. The results are large enterprises, only rendered possible by combinations of capital; great corporations, monopolizing the production of all the comforts and many of the necessaries of life; immense farms and pastures, flooding the markets of Europe with cheap meats and grain, curtailing the rents of the landlords, and depressing the value of our lands; the crushing out of small producers, and the centralizing of production where labor and material can be obtained the cheapest." That the organizers of the great enterprises which are swallowing up the smaller appropriate to themselves "an apparently disproportionate share of the profit" is ascribed to "a universal law that the man who develops extraordinary capacity in any direction receives an extraordinary reward."

Thus portraying the present tendency to consolidation, Justice Brown thinks "we may safely assume that it will be prolonged into the twentieth century; . . . that the great powers of Europe, which have already parcelled out among themselves almost the entire continent of Africa, will look for new fields of conquest in the extreme east: that the process of absorption will go on with the usual indifference to the wishes of the native populations; and that another hundred years may see the entire eastern hemisphere under their control. It will be your duty to see that their rapacity does not extend to the western hemisphere. The lust of conquest, like that of acquisition, knows no bounds."

The great changes that will make the twentieth century remarkable are likely to be social rather than either political or legal. Labor and capital are regarded as arrayed against each other in strife. On the one hand the gigantic trusts, on the other the labor combinations, which combinations of capitalists have, by example, taught the lesson of organization. "The reconciliation of this strife, if reconciliation be possible, is the great social problem that confronts us." Individualism for 4000 years is regarded as having progressed with civilization; in fact, the history of the one is that of the other also. Hence "the destruction of private property cannot be the solution sought." Judge Brown asserts that under "our present social system, with all its faults, the civilized world is constantly growing richer, freer, more prosperous than ever before,—the richer less ostentatious in the display of their wealth; the poorer better housed, better clad, and better fed. Certainly the burden of proof is upon those who claim that this civilization is a failure. Nothing can demonstrate the soundness of their principles so well as a practical experiment in socialism upon a large scale. If a successful experiment on that scale could be offered to the world, they might have some title to claim that civilization should be organized upon that model."

"While it is entirely true that the business methods of the past 30 years have tended to increase enormously the fortunes of a few, and thus to widen the gulf between the very rich and the very poor, it is wholly untrue that the poor as a class are either absolutely or relatively poorer than before. Indeed the number of small, but comfortable, houses in every part of the country, as well as the reports of savings-banks and building and insurance associations, prove incontestably that the poor have shared in the prosperity of the rich, and that the average standard of comfort was never higher than at present. Indeed, the average working-man of to-day lives better and possesses more of the comforts of life than the average noble of 600 years ago. The sins of wealth, though many and grievous, have not generally been aimed directly at the oppression of the poor."

The "gradual enlargement of the functions of government" and "the ultimate control of natural monopolies" is the most probable result to which Justice Brown looks forward. As coming from a chief justice of the United States, this address will seem singularly lacking in originality of expression, to say nothing of originality in thought. It may be said, however, that so much has been thought, said, and written as to probable results of present tendencies that not much of originality or of added force to old arguments restated was to be expected, even from this high source. Corruption and bribery, which the speaker was unwilling to attribute solely to corporations, are spoken of as "a great present danger." A "government by the better classes" is suggested as a possible remedy for this; but a government by the whole people was the original American scheme, from which government by an aristocracy would be a wide departure. It is too late to dream of any such system. Trusts may be carried to a revolutionary extent, and are already a just subject of public alarm. On the whole, the speaker does not regard "the outlook for a permanent peace between capital and labor" as "an encouraging one," and he concludes his address by saying that "it has been given to the nineteenth century to teach the world how a great republic can be founded upon principles of justice and equality; it will be the duty of the twentieth to show how it can be preserved against the insidious encroachments of wealth as well as the assaults of the mob."

Balance of Occupations.

IN the *American Magazine of Civics* Mr. R. C. Barnett endeavors to trace up from primitive society the course of evolution of occupations, diversity in which is attributed to the want of homogeneity in human society, as well as diversity of wants, which latter, in fact, is a result of non-homogeneity. "The incident force of want acting upon the slightly heterogeneous group" (primitive association) will have the tendency toward differentiation of acts. At the same time that differentiation occurs, there will be a tendency toward integration of the members of the tribe into groups,—for example, warriors, hunters, fishers, etc. This differentiation and concomitant integration, this process of evolution, will continue till equilibrium is reached. To answer the question: "what must be the correlation of wants and acts?" he imagines an ideal typical society, and the changes that would attend its development, and thus attempts to deduce laws for its growth. Thus he concludes that, when the condition of economic equilibrium is reached, the "relation that would then exist among men would be that of equality of opportunity,—that is, each and every member of the social organism would have an equal opportunity to work to his full capacity, and the relation of occupations would be so nicely adjusted that each would receive the highest possible wages. This would not be the kind of equality that statutes grant, but rather the kind that nature seeks to maintain. When this state of equilibrium is reached, the path of least resistance will have been traversed. There will be no inducement for a man to change his occupation. He will get the most and the best that his individual efficiency permits.

"But what are the conditions of equilibrium? What relation will then exist among the occupations? The ultimate recompense of any man in any occupation is a portion of the primitive output. Then, for a given number of persons, the greater this primitive output, the greater will be each one's portion. The great desideratum, therefore, is that the primitive output be the maximum." Mr. Barnett illustrates this by an imagined typical society of farmers. "The first derivative occupation would be the making of farming implements," and there will be a series of derivative occupations. He finds between the state wherein the farmers, lacking tools, would produce a relatively small output, and a state wherein the tool-makers would make more tools than the farmers could use, a point where the tool-makers could make just the right quantity and quality of tools. That would enable the farmers "to use the tools to their utmost capacity. This maximum being reached, the individual's shares would be the maximum also. This would be the best that he could do. There would be no inducement for any one to make a change, for in doing so the balance of occupations would be destroyed and the output would become smaller.

"Now, the numerical relation between the number of men engaged in any primitive occupation, and the number of men engaged in its first derivative occupation, cannot be given here, for want of sufficient statistics; but the general rule may be stated thus: (*a*) There is one, and only one, certain ratio which permits of the maximum output being realized. (*b*) The maximum primitive output and balance of occupations (equilibrium) are concomitant effects of the same cause, and are realized only when the certain ratio is attained."

No man, according to this theory, would leave the primitive to engage in a derivative occupation, unless by this he could increase "the output with respect to the amount and character of the work," and thus gain a larger share of total output in the derivative occupation.

The general tendency of society is regarded as toward the ideal equilibrium herein delineated, and the author thus reaches a cause assigned for "the economic evils which confront us to-day. . . . This cause is the unbalanced condition of occupations. There is a strong tendency nowadays for people to leave the primitive and enter the derivative occupations. As we have previously seen, this tends to lessen the primitive output; but at the same time this tendency is counterbalanced up to a certain degree by an increased efficiency. Beyond this point there is an actual decrease in the primitive output. It is the primitive output that is consumed in satisfying wants; and the man who produces this primitive output will have the first chance to use it. The derivative output will not satisfy directly any wants. It must be exchanged for the primitive. If there is a scarcity of the primitive and an excess of the derivative output, all who are in the derivative occupation will not have a chance to exchange their output for a portion of the primitive. They will suffer more than those in the primitive, who have a better opportunity to satisfy their wants. Therefore it is better for the social organism that there should be a greater tendency toward the primitive occupations than toward the derivative. In other words, there would not be such dire suffering if there were an excess of farmers as there would be if there were an excess of mechanics. Therefore, the tendency of legislation should be, for the present at least, to increase the desirability of farming rather than otherwise."

Of course this all leads up to the inevitable "single tax" theory, and the conclusions are that encouragement for a return to the primitive occupation of farming should be sought, and that this encouragement will result from a "change in our system of land tenure that would permit of any one going to the best available unused land and farming it."

Protection and Farmers.

UNDER this title the *Social Economist* for August alleges that "the doctrine of protection as a national policy is still very imperfectly understood." It cites the attitude of the free-silver advocates as proof of the allegation. "They insist that silver is entitled to protection as much as is woollen cloth, silk, pottery, or any other American product. To them the adequate protection of silver means that the government shall buy all the silver they produce at $1.29 an ounce, whether it needs it or not, solely to keep the price of silver up to that figure, insuring a profit of from 40 to 50 per cent. If this kind and degree of protection is not conceded by either the Republican or Democratic parties, the free-silverites threaten to organize a free-silver party." The scheme, which originated in California, and which aims to secure from the government a bounty for all agricultural exports equal to the cost of transportation from American ports to Liverpool, is cited as further proof that the doctrine of protection is widely misunderstood. The originators of the movement (said to have received the approval of a considerable following) argue "that farmers have to sell their products at free-trade prices abroad and less than free-trade prices at home by the amount of transportation," while they are "compelled to purchase the articles they consume, but do not produce, at protection prices, due to the discrimination of our tariff laws in favor of American manufacturers." They declare that they will no longer submit to this alleged "double injustice," and that they will offer themselves to the Democrats or Populists, or organize an independent party to right the wrong. The article under review attempts to show that the view on which this action is based is erroneous.

"The claim that the price of farm products, such as cotton, corn, and wheat, is fixed at Liverpool is one of the economic fallacies that free-trade doctrinaires have dinned into the ears of farmers for the purpose of making them believe that they got no benefit from protection. It is not, and never was, true." This is followed with an argument to show that this scheme is not protection, but paternalism pure and simple, and that it "is exactly like asking the government to give every farmer a check on the United States treasury once a year equal to what it would cost to send his entire crop to Liverpool, even though he did not send a bushel." As to the lowering of prices, it is said that the "prices of manufactured products, taken as a whole, have been lowered nearly ten-fold as compared with agricultural products. In fact, the price of many agricultural products has not been lowered at all; beef, mutton, eggs, butter, etc., are higher now than they were three-quarters of a century ago, while nearly all manufactured products have been reduced from 20 to 80 per cent."

"The plea that farmers have been injured by the development of manufacturing industries is one of the worst heresies of our time, and those who advocate it are the real enemies of the farmers. In all the schemes of Populism nothing has hitherto been proposed which savors more strongly of economic insanity than to give a bounty on agricultural exports. It is contrary to every principle of economic and national development. It is the advocacy of such paternal schemes as this that brings protection into disrepute. It is time that a sharp and broad distinction was drawn between protection and paternalism,—distinction so clear that absurd projects like asking the government to purchase the product of one industry or pay the freight of others merely to insure profits could not be publicly announced without relegating its author to economic oblivion.

"Protection is not the doctrine of government ownership, either of production or products, but of protecting the opportunities of Americans to produce for and sell their products in the American market. For the government to assume responsibility for either producing or purchasing products is purely paternalism,—not protection at all. If this were distinctly understood, neither silver producers nor producers of any other commodities would ever think of demanding as the price of political allegiance that the government should become the 'unlimited' purchaser of their wares at a fixed price, equivalent to nearly double the cost of its production."

Pictorial Financial Arguments.

THE way in which the pencil of the artist and the crayon of the lecturer may be used in argument of a specious, but misleading, kind in the discussion of financial questions is the burden of a readable article in *Rhodes's Journal of Banking* for July. One of these drawings on a blackboard is a pair of scales. In one pan are bags of gold; in the other, wheat and cotton. "An individual labeled 'Financial Operator' presses down the pan containing wheat and cotton, and lifts up the pan containing gold. . . . At his side is a huge sack filled with small bags of so-called hoarded gold." Of course the idea intended to be conveyed is the disturbance and depression of prices by rich financiers for their own benefit.

Of another picture—a cube said to represent all the gold there is in the world—it is remarked that "why this should be anything pertinent to the argument does not appear. The deviser of the design says it shows that gold is too scarce a metal to furnish all the money required, and the fly gobblers take his word for it. . . . The whole population of the world can stand in a space 12 miles square, allowing every man, woman, and child 2 sq. ft. of space. But this does not prove that there ought to be more or less people, or that the world is not well populated."

"Another design represents Columbus discovering America, and its counterpart represents the statue of Columbus at the World's Fair in Chicago in 1893. The idea is that in 1492 the live Columbus found a lot of gold and silver bullion in the new continent, and that his statue in 1893 overlooked a scene of commercial ruin caused by the refusal of the world to use as money the silver he discovered. Probably Columbus, if he could have returned in person and visited America in 1893, would have been more struck with the wonderful wealth of the United States than with its poverty during a temporary depression of business.

"The next design on the blackboard is a colossal figure 'one.' This illustrates the monetary unit. Probably the public does not require this illustration to understand that a unit means one.

"One design shows two little men with heads in the shape of bags of money, walking arm in arm to a door labeled 'United States Mint.' One is labeled 'gold,' the other 'silver.' The next represents gold inside the door grinning at silver, who now lies on his back dead, stabbed with a huge quill pen. This represents the so-called 'crime of 1873.'

"Of two other designs one represents the happy condition of labor in 1872 under alleged bimetallism, and the other the distressed condition of labor in 1894 under monometallism. As this design would prove just as much if one were labeled prosperous times under bimetallism in 1857, it is of universal application, and proves nothing except to those disposed to take the designer's word for it all.

"The arguments of the monometallist are portrayed by a figure of a man who, with fists clinched, is shouting 'frauds, blatherskites, thieves, swindlers, repudiators, charlatans, lunatics.' This might as well be labeled 'silver advocates,' and be just as true to facts.

"Another design represents two hands pulling two buttons by cords attached to a level beam. If either cord is relaxed, the button attached will drop down. These hands and cords are meant to show the effect of demand on price. If the demand for silver, or gold, or iron, or lead, or copper were the same, then the value of equal quantities of each of these metals would be the same. No account is taken of the supply. According to this illustration, a sufficient pull from the hand above would bring up an ounce of mud to an equality with an ounce of gold."

A quotation from Rabelais fitly concludes the article, and casts well-deserved ridicule on all this kind of claptrap.

Commercial Education in Europe.

AN abstract of a paper read by Mr. William Layton before the Society of Arts (*Engineering News*, July 4) makes a claim for superiority of the continental as compared with the English system of commercial training. In Mr. Layton's view the first-named attains to the rank of "thorough education," while all he can say for the latter is that it is "mere instruction." Belgium, leading the van, has in the "Institut Superieur de Commerce," established in 1853, furnished a model for similar institutions in France, Switzerland, Germany, and even Japan.

"The first difficulty encountered was the general belief that a small amount of education was sufficient for a man destined to be a trader, and pupils were scarce. But the government saw fit to share the expense with the corporation of Antwerp, and the school was started with 51 students of commerce. This number steadily increased, until in 1892 the attendance reached 945, of which 406 were foreigners; on that date also 249 graduates of the school occupied the position of chiefs in the most important mercantile firms of Belgium; 218 were bank managers or commission merchants; and the consular positions of the country were filled with them. It is evident that the Institut has well served the purpose for which it was founded. Students are divided into two classes,—the 'regular' and the 'free.' The first attend all lectures in a prescribed course, with a view of obtaining a diploma at the end of 2 years; the second class only follow lectures deemed best fitted to advance the student in a selected career. The entrance examination requires a competent knowledge of single and double-entry bookkeeping, geography, history, natural philosophy, chemistry, geometry, arithmetic and algebra, commercial law, and the elements of political economy. In fact, the conditions of entrance are about the same as those demanded for matriculation at the English universities. The 'free' student need not pass this examination. The course of instruction is practical as well as theoretical. The transactions of a large commercial house and the operations of a counting-house are minutely simulated, and the student is obliged to carry on the 'office' correspondence in French, German, and English. He must also be competent to correspond in one other foreign tongue, generally Spanish, Italian, or Dutch. The principles of political economy, of international commercial law, and customs regulations are inculcated, and the student is made to especially study foreign markets in reports sent in periodically by Belgian residents abroad.

"A well-furnished museum and a proper staff make the student well acquainted with the vegetable, mineral, and animal products in which he may be some time called upon to trade; and this department includes as well the geography of foreign countries and their commercial condition, as studied from carefully-compiled data, the relative value of raw materials from different sources of supply, and the latest consular reports from all countries."

THE TECHNICAL INDEX—1895.

***Current** Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.*

*1. The Business Situation in Review. Newton Sharp (The outlook for autumn trade). Eng Mag–Sept. 3600 w.

*4. Labor Legislation in the United States. George Kirby Holmes (The multiplicity of needless laws.) Eng Mag–Sept. 3000 w.

12. Commercial Education in Europe (Abstract of paper read before the Society of Arts by

William Layton—Best methods of fitting young men for trade and manufacturing). Eng News–July 4. 1200 w.

45. The Present Status of the Trade School Movement. C. R. Richards. Ry Rev–July 6. 2400 w.

*62. The Financial Situation (Economically considered). Bank Mag, Lond–July. 3500 w.

104. Railroad and Industrial Development Essential to General Prosperity) Editorial. Home market for agricultural, mining and forest products). Mfrs Rec–July 12. 1000 w.

†144. Liquor, Land and Labor. X. Y. (Local option—sale of liquor—in England, and a criticism of individualism as opposed to socialism). Fort Rev–July. 3500 w.

†194. The Money Unit of the United States. E. O. Leech (A critique of The Free Silver Argument. W. A. Harvey in the Forum for June). Rhodes' Jour of Bank–July. 2500 w.

†195. Competition from Silver Standard Countries. Worthington C. Ford (Effect of variation in price of silver upon the productive and exporting capacity of silver-using countries). Rhodes' Jour of Bank–July. 3500 w.

†196. Pictorial Financial Arguments (A critique upon the pictorial or graphic method in dealing with financial statistics and discussion of the money question). Rhodes' Jour of Bank–July. 2200 w.

†197. World's Production of Gold and Silver (Bureau of the Mint Estimate for the calendar year, 1894). Rhodes' Jour of Bank–July. 500 w.

*389. Belgian Tariff Modifications. Bd of Tr Jour–July. 3500 w.

*390. Tariff Changes and Customs Regulations. Russia. The New Harbor at Theodosia (Crimea). Norway. North Sea and Baltic Canal. France, Spain, United States, Colombia, Peru, Tahiti, Bombay, Malta, Canada, South Australia, Victoria.—Bd of Tr Jour–July. 5000 w.

*391. The Twentieth Century. Henry B. Brown (Summary of changes of the past century. Changes of the next promise to be social rather than legal or political. Perils of municipal misgovernment, corporate greed and tyranny of labor). Forum–Aug. 7000 w.

*393. Is an Income-Tax Socialistic? W. H. Mallock. Forum–Aug. 12500 w.

*395. The Deep-Waterways Problem. E. V. Smalley (The demand of the west for an open waterway to the sea). Forum–Aug. 2800 w.

444. Gold and Silver.—Their Production, Uses and Logical Ratio. Richard P. Rothwell (Statistics and conclusions). Eng & Min Jour–July 27. Serial. 1st part. 2600 w.

*448. Protection and Farmers (False economics; bad public policy). Soc Ec–Aug. 2500 w.

*449. The Cost Theory of Value (Criticism of article in "The American," Phila.) Soc Ec–Aug. 1800 w.

*450. The Vacuum in Our Currency System (An attempt to prove that there is not solidarity and community of interests between the Government, bankers, merchants and people, and concludes that the fate of silver in America waits for legal specie payments). Soc Ec–Aug. 2200 w.

*451. What Brought the Factory Acts? Wilbur F. Crafts (Cruelty and injustice to men, women and children. The problem of equal rights in production). Soc Ec–Aug. 1500 w.

454. Land Tenure in Tuscany. Janet Ross in Littell's Living Age (Equal division between owner and tiller of all crops gathered from the soil). La Planter & Sugar Mfr–July 27. 2000 w.

†458. Leo XIII and the Social Question. J A. Zahm (An exposition of the origin, character and history of the social question from the Roman Catholic point of view, and the gist of the Pope's teaching regarding it, as gathered from letters and encyclicals). N Am Rev–Aug. 6000 w.

†568. An Arbitration Treaty between Great Britain and the United States. George H. Emmott (The substance of an address delivered at Lake Mohonk on the question of influencing public opinion in favor of the settlement of international disputes by arbitration). Arena–Aug. 2200 w.

*573. Bimetalism and Currency. Joshua Douglass (What money is. Condition of affairs in the United States during past twenty-five years). Am Mag of Civ–Aug. 4800 w.

*574. A Plea for a Sound Currency and Banking System. Allen Ripley Foote. Am Mag of Civ–Aug. 4500 w.

*575. The Necessity of State Labor Tribunals. Norman T. Mason (The decisions of such a tribunal more likely to be just to both parties). Am Mag of Civ–Aug. 2400 w.

*577. Balance of Occupations. R. C. Barnett (An article purposing the investigation of the actions that minister to the wants of man, and their effects). Am Mag of Civ–Aug. 3500 w.

643. Elements of a Plan of Ship Protection W. W. Bates (Protective measures advocated are chiefly discriminating duties, bonding privileges, and export bounties). Sea–Aug. 8. 4000 w.

*664. The Conduct of Business by Companies (Attention called to the report by the Board of Trade on the Companies Winding-up Act, which describes what has taken place recently in the way of the liquidation of such companies). Bank Mag, Lond–Aug. 2500 w.

*665. The Recovery from the Panic of 1893 in the United States. D. M. Frederiksen (Why it was slow. Why we may consider the revival assured. Causes affecting). Bank Mag, Lond–Aug. 5000 w.

†681. Rubber and Other "Industrials" (Editorial comparison of "industrials" in American and Foreign Stock Exchanges). Ind Rub Wld–Aug. 10. 1200 w.

†682. Wanted, a New Foreign Policy (Editorial on trade relations with countries on American soil). Ind Rub Wld–Aug. 10. 800 w.

MARINE ENGINEERING

The Yacht as a Naval Auxiliary.

THE marvellous growth of yachting in the United States during the last 20 years is regarded by Hon. William McAdoo, assistant secretary of the United States navy, in the *North American Review* for August, as " one of the many signs of the turning of our people again to the sea, and the reestablishment of our merchant marine in the proud position it held in the days of the famous clipper ships."

There are, or were, at the beginning of the present year, " ninety regular organized yacht clubs in the United States," while " in all the remainder of the hemisphere there are but seven,—three in Canada, and one each in Nova Scotia, Cuba, Jamaica, and the Argentine Republic." Of the ninety clubs in the United States the distribution by States is as follows : " New York heads the list with thirty-two clubs ; Massachusetts has nineteen ; New Jersey, ten ; Connecticut, seven ; California and Rhode Island, three each ; Maine, Pennsylvania, Maryland, and Florida, two each ; North Carolina, South Carolina, Alabama, and Louisiana, one each ; and there are ten clubs along the lake region on our northern boundary, two of which are included in the thirty-two credited above to New York. Of the clubs enumerated as to States, at least forty are located in New York harbor, Long Island sound, and their adjacent waters. The interior waterway communication along our coast line, so well illustrated in the recent trip of the torpedo boat Cushing, gives additional impetus to yachting through the enormous water course it is now possible to traverse in even the smallest class of yachts with perfect safety, and to the rivalry thus offered through visiting yachts from various sections of the coast." Mr. McAdoo thinks that both the yachts and the men interested in and engaged in yachting may be made of great use to the country ; the men become especially well trained in yachting service, and the vessels, though not now such as could be of much use to the government, might be, "by mutual agreement between yacht owners and the government when the plans are under consideration. . . . constructed to answer the double purpose of yachts in time of peace and naval auxiliaries in time of war." Three classes of yachts are named as adapted for use as naval auxiliaries.

" 1. The large, full-powered steam yachts, like the Atlanta, Corsair, Conqueror, Columbia, Electra, Eleanor, Margarita, May, Namouna, Oneida, Peerless, Sagamore, Sapphire, Utowana, and Valiant.

" 2. The auxiliary type with moderate steam and sail power, as illustrated by the Intrepid and Wild Duck.

" 3. The high-speed boats for sheltered waters and comparatively short runs, like the Now Then, Say When, Helvetia, Norwood, and a host of others."

There seems to have been some doubt in the mind of the author as to whether this scheme possesses the element of practicability. It appears to us highly impracticable. The primary reason for building yachts is that they give pleasure to their owners. They are in their nature pleasure boats. All except the larger ones are stinted for room, and an attempt to make them fit for use in auxiliary naval service would necessarily either curtail the room or necessitate larger vessels. As to the agreement between the owners and the government, Mr. McAdoo does not see clearly how it could be reached, but seems to have well-defined ideas as to what the government should demand on its part. " The government might furnish inspectors to superintend the building ; provide all the supports, racks, bulkheads, fittings, and outfits of a military character ; have the yachts regularly inspected as to hull fittings and machinery and the competence of the master and engineers ; and, finally, enroll them in a naval reserve, with the right to fly a special flag and to uniform their officers and crew in conformity therewith. In return the government should have the right to charter or purchase them in time of war, and, by special agreement, to use them for a few days each year for drill or training purposes at a time when the owners would need them least."

We are asked to take for granted that this would not spoil a yacht in any way for the purposes for which the owner built her,—an assumption which most people at all acquainted with yachts and their uses will regard as absurd. Moreover, in this scheme the government is not to offer anything to the owner "in the nature of a bonus." The owner is, therefore, provided he be patriotic enough, to submit himself to grave inconveniences and his yacht to government inspection, and to the increased weight of "racks, bulkheads, fittings, and outfits of a military character," for nothing except the gratification of his patriotic sentiments. We opine that he will prefer to build and use yachts as heretofore, and, when his patriotism becomes so imperious that he must gratify it, find some other way of giving it expression. Perhaps we may next hear of a scheme emanating from the war department to the effect that we shall use our country houses for the double purpose of a retreat in summer and as arsenals which could be used as military auxiliaries in war-time, and an agreement between owners and the government to have them built under the superintendence of government inspectors.

The Laws of Similitude as Affecting Naval Construction.

In an abstract from a memoir published in the *Bulletin de l'Association Technique Maritime, Engineering* (London, July 12) gives important data and formula. With reference to alteration of drawings of an engine made to a given scale, the author reaches the conclusion that, as regards stresses depending upon static forces (pressure of steam), the factors of safety remain the same, whatever be the scale. As to stresses due to weight of the engine and movement of the vessel in a seaway, the law of similitude does not hold. The rapidity and amplitude of movements of the vessel must be taken into account. "No engine of great power fitted in a light hull will work well, unless secured to the hull at several points. This is necessary, not only on account of the weakness of the base to which it is attached, but also because of the slightness of the connection between the upper parts of the engine and the bed-plate. The hull, in fact, contributes to the solidity of the engine. This arrangement would be inadmissible in very large vessels, on account of the excessive stresses which would be thrown upon the engine. The dimensions of engines of this type cannot, as a rule, be indefinitely augmented. The author has constructed engines working under these conditions, but in his latest torpedo-boats, although they are connected to the hull at several points, it is for a different purpose. The engines are more rigid than the hull, and, if the base to which they were secured were sufficiently strong, they would not require any further attachment. The following rules are applicable to them. As angles of rolling of 40° and 45° have been observed, it would seem advisable, in the case of vertical engines attached to the hull by the bed-plate only, to make them so secure that they could support themselves in a horizontal position. If this condition be fulfilled, the stress per unit of section is proportional to the linear dimensions. It follows that parts subjected to such special strains should increase more rapidly with increase of size than the scale would indicate, and therefore the weight of the engine will increase rather faster than the cube of the dimensions."

In order that the fall in pressure shall be independent of the scale to which the engine is drawn, the revolutions must be inversely proportional to the linear dimensions. Except that, as stated, parts exposed to special strains should increase more rapidly with increase of size than the scale would indicate, a drawing of an engine to work at a given steam pressure may be altered to any scale, without alteration of stress on a unit of section of any of the working parts, the friction of any of the rubbing parts, or the fall in pressure, provided the rule be observed that the revolutions be inversely proportioned to the linear dimensions, as above set forth.

The power of the engine will, under the same conditions, "be proportional to the square of the linear dimensions, and the weight per horse power will be proportional to the linear dimensions"; that is to say, "that is true for the main engines, shafts, bed-plate, connecting rods, etc.," but "not for condensers and boilers."

The author declares that he has "frequently constructed engines of different sizes from the same plans by altering the dimensions to scale, thereby saving much time and labor. For example, the engines of the Russian torpedo-boats Revel and Sveaborg, constructed in 1885, were similar to those of the Balny, the scale being increased in the ratio of 1 to 1.9, and in 1891 the drawing of the first-class torpedo-boat engines of No. 147 type served for the construction of the twin-screw Lancier type, and for the steamer Augustin Normand, the scale being reduced to 0.9 in. in the first and to 0.81 in. in the second. Such progress has been made in the manufacture of large steel forgings and castings that the author would not hesitate to use the same drawings for the construction of much larger engines,—3000 or 4000 indicated horse-power, for example,—taking care to provide against special stresses due to the movements of ships at sea."

—		Proportional Values, the Number of Revolutions being	
		Independent of the linear dimensions of the engine.	A maximum such that ratio of inertia to static stresses is constant.
Number of revolutions	n	$\frac{F}{\lambda^3}$ $\frac{V^3 D^{\frac{2}{3}}}{\lambda^3}$	$\frac{1}{\lambda}$ $\frac{1}{F^{\frac{1}{2}}}$ $\frac{1}{V^{\frac{3}{2}} D^{\frac{1}{3}}}$
Speed of vessel … …	V	$\left(\frac{F}{D^{\frac{2}{3}}}\right)^{\frac{1}{3}}$ $\lambda\left(\frac{n}{D^{\frac{2}{3}}}\right)^{\frac{1}{3}}$	$\left(\frac{\lambda}{D^{\frac{1}{3}}}\right)^{\frac{2}{3}}$
Displacement … …	D	$\left(\frac{F}{V^3}\right)^{\frac{3}{2}}$ $\left(\frac{n\lambda^3}{V^3}\right)^{\frac{3}{2}}$	$\left(\frac{\lambda}{V^{\frac{3}{2}}}\right)^3$
Indicated horse-power…	F	$n\lambda^3$ $V^3 D^{\frac{2}{3}}$	λ^2
Linear dimensions of propelling machinery	λ	$\left(\frac{F}{n}\right)^{\frac{1}{3}}$ $\frac{V D^{\frac{2}{9}}}{n^{\frac{1}{3}}}$	$F^{\frac{1}{2}}$ $V^{\frac{3}{2}} D^{\frac{1}{3}}$
Weight of propelling machinery without condenser … … …		$\frac{F}{n}$ $\frac{V^3 D^{\frac{2}{3}}}{n}$	$F^{\frac{3}{2}}$ $V^{\frac{9}{2}} D$
Weight per horse-power of propelling machinery without condenser .. .. …		$\frac{1}{n}$ $\frac{F}{n^2 \lambda^3}$	λ $F^{\frac{1}{2}}$ $V^{\frac{3}{2}} D^{\frac{1}{3}}$
Ratio of linear dimensions of engine to those of hull … … …		$\frac{\lambda}{D^{\frac{1}{3}}}$ $\left(\frac{F}{n D}\right)^{\frac{1}{3}}$	$V^{\frac{3}{2}}$ $\left(\frac{F}{D^{\frac{2}{3}}}\right)^{\frac{1}{2}}$

A *résumé* of the laws of similitude is given in a table of formulæ, which presents the subject in such concise form that it is worth reproducing. "When a satisfactory design of engine and hull is once arrived at, it is possible to make use of this table to design a new vessel not differing greatly in size from the model," as "any one of the principal elements can be deduced from it, if the others are given." The paper concludes with a discussion of similarity in trials and models of ships.

Coupling Boilers of Different Systems.

M. PIERRE SIGAUDY, in a paper read before the recent Paris meeting of the Institution of Naval Architects (*Practical Engineer*, July 5), expressed the opinion that the speediest method of removing the remaining scepticism as to the safety of water tube boilers is to fit together boilers of the old and new types "on the same ships, thus giving the possibility of getting up steam quickly, which is generally of great importance." He then presented an account of a successful trial of this arrangement made by the Société des Forges et Chantiers, at Havre, on the tug boat Adour No 3, built for the Bayonne chamber of commerce. This tug is 118 ft 1 in. long, 23 ft. 7¼ in. wide, 13 ft. 1½ in deep, 8 ft. 0½ in. in draft, and has engines of 700 h. p.

The conditions of trial were: speed of 11 knots during 6 hours, the coal consumption not to exceed 21 lbs. per h. p.; the getting up steam to be done within 30 minutes. "Of course it is most important for a tug-boat to get steam up as quickly as possible, especially when employed on salvage service." Two different kinds of boilers were put on board, "one of the

Normand type, and one return-tube boiler of the ordinary type. M. Sigaudy says they would rather have coupled two Normand boilers, had not the owners asked that at least one of the two should be of the usual type, as they feared for the results of two water-tube boilers." The Normand boiler had a heating surface of 1560 sq. ft., a steam space of 32.82 cu. ft., a water volume of 82.58 cu. ft., and a grate surface of 34.70 sq. ft. The return-tube boiler had a heating surface of 1232.55 sq. ft., a steam space of 176.45 cu. ft., a water volume of 345.13 cu. ft., and a grate surface of 38.73 sq. ft.

The experiment was embarrassed by the general arrangement. "The boiler of the Normand type is placed in the forward compartment, with its funnel forward and stoke-hold aft; the engines are in the center compartment, and the after compartment contains the return-tube boiler with its stoke hold placed forward. No special arrangement has been made for the steam and feed pipes, one single steam pipe making the communication between the two boilers through the engine-room, with a branch to each engine. In the same way the feed pipe is common to both boilers, and communicates with two independent feed pumps placed on the side of the engine room, each one of which is sufficient to feed the two boilers. A single pump was working during the trials. The boilers steamed satisfactorily during both the preliminary and the official trials." The time for getting up steam with the Normand boiler was, in the two trials, from 22 to 23 minutes. At the official trial for coal consumption, which lasted for 6 hours, the mean speed being 11 knots and the mean power 673 h. p., with 29.5 revolutions per minute, the consumption of coal was 1.81 lbs. per horse power per hour, the fuel used having been *briquettes d'Anzin*. The engines, running at full speed, indicated 731 h. p. The quantity of coal burned in each boiler was pretty nearly the same on each trial. These results are regarded as conclusive of the practicability of combining the two systems, under the most difficult conditions,—"that is to say, coupled and in different stoke-holds,"—and they indicate that any fear of unsatisfactory results under such conditions is not justified in practice.

A New System of Towing.

The Shaw & Speigle steam-towing machine has met with such success that it bids fair to become an important factor in marine traffic. *The Chemical Trade Journal* says it has been adopted by the chief coal and ore transport companies in the United States, and that an experiment is now in progress to determine its practicability for towing tank barges carrying oil in bulk. Its distinctive feature is said to be that, by means of its driving and cushioning steam cylinders, there is provided an elastic steam cushion, without which the hawser would be continually straining and frequently breaking. A manilla hawser, although more elastic than a steel hawser, is very bulky to handle or to stow on a barge, and it also becomes very expensive on account of its ordinary wear and tear. A steel-wire hawser will last apparently for an almost indefinite time without stranding or even straining, as appears from practical use. In its principle and mode of working the tow barge is borne entirely by the steam pressure in the cylinders. The wire hawser is wound on a drum that is driven by a pinion gear on the crank shaft of the engine, which meshes with the gear on the drum shaft. This machine has a regulating reducing steam valve, in which the opening is increased or diminished according as the strain on the hawser increases or diminishes. The action of the machine is as follows: in a seaway, as the vessel pays off, thus increasing the strain on the hawser, the drum begins to revolve and to pay off the hawser; this action opens the regulating valve and increases the steam pressure in the cylinders until the pressure is sufficient to equal the strain. Then, if the strain increases on the hawser, the pressure in the cylinders will revolve the drum and wind the hawser in. In this way the machine is prevented from paying out the whole of the hawser, and only enough is paid out to relieve the extra momentary strain on the hawser, and thus prevent its injury or its breaking. When the tow barge casts off the hawser, then the regulating valve is disconnected, and the machine becomes in effect a simple hoisting drum to be started to wind up the hawser. It is claimed that this invention is also well adapted for ocean steamers, as better assistance can be rendered to disabled vessels in bringing them to port than can be offered by any other means heretofore available. The mechanical principles upon which this system is based are so obviously sound, as to render it surprising that they were not sooner applied to cable towing.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*6. The Earliest Transatlantic Steamships. Ill. Samuel Ward Stanton (Covering the period from 1819 to 1855). Eng Mag–Sept. 3700 w.

†81. Cellulose Protection for War Vessels and for the Merchant Marine. Ill. B. P. Wiltberger (Abstract of a paper read at the stated meeting of the Franklin Institute, Feb. 20, 1895. Describes the construction and use of the Colome's leak arrester). Jour Frank Inst–July. 300 w.

136. Scotch Shipbuilding in June (Orders booked; ships launched; total output). Mech Wld–July 5. 400 w.

*139. On Water-Tube Boilers. Ill. J. A. Normand (Treats of necessary conditions for resisting intense firing; strains due to expansion of tubes; circulation as related to heat transmission; combustion; section of passage and length of travel of hot gases, etc. An able discussion). Steamship–July. 3600 w.

*140. The Royal Mail Steamer "Vega." Ill. (Descriptive). Steamship–July. 2000 w.

*148. Improved Method of Fitting Ship Plating. Ill. (A method patented some years ago but now coming into use). Marine Eng–July 1. 900 w.

*149. Syer's Apparatus for Raising Sunken Ships. Ill. (Vessels filled with water are sunk and attached to the ship to be raised. The water is then displaced in the lifting vessels by blowing air into them). Marine Eng–July 1. 700 w.

*150. On the Utility of Calculating the Whole External Volume of Ships, and Constructing the Complete Scale of Solidity from the Points of View of "Stability," "Tonnage," and "Load-Line." M. Daymard (The author thinks a uniform rule for computing tonnage possible on the line pointed out). Marine Eng–July 1. 1300 w.

*151. On Coupling Boilers of Different Systems. Pierre Sigandy (The practicability and advantage of coupling the old with the new systems is discussed). Prac Eng–July 5. 600 w.

*171. Distilling Apparatus on H. M. Cruiser "Terrible." Ill. Engng–July 5. 400 w.

*225. Ocean Towing of Petroleum Tanks (Describes the Shaw and Speigle towing machine, by which this tank-towing has been rendered possible). Chem Tr Jour–July 6. 400 w.

*247. Water-Tube Boilers (Discussion pro and con at the Royal United Service Institution). Trans–July 5. 800 w.

302. The Marine Gasoline Engine and Launch. Ill. (Descriptive of motor built by the Globe Gas Engine Co). Am Ship–July 18. 700 w.

*352. Clydebank Shipbuilding and Engineering Works. Ill. (Descriptive: interesting). Engng, Lond–July 12. Serial. 1st part. 4500 w.

*355. The Laws of Similitude as Affecting Naval Construction. Abstract. J. Augustine Normand. Engng, Lond–July 12. 2400 w.

380. The Lake Steamer North Land. Ill. (Descriptive). Sci Am–July 27. 700 w.

398. New Gunboats. Ill. (Types; engines; armaments, etc). Sea–July 25 1600 w.

425. A Steel River Steam-boat. Ill. (Sections). Eng News–July 27. 650 w.

†457. The Yacht as a Naval Auxiliary. William McAdoo (The present growth in American yachting is regarded as boding well for the future both of the United States Navy and the Mercantile Marine). N Amer Rev–Aug. 3000 w.

502. The International Cup Races. Editorial. Sea–Aug. 1. 350 w.

*503. The Ship of the Future. Nathaniel Barnaby (Thornycrofts' steadying apparatus). Eng Rev–July 20. 1000 w.

*504. The Application of Hydraulic Machinery to Shipbuilding. Ill. Ralph Hart Tweddell. Eng Rev–July 20. Serial. 1st part. 800 w.

*505. The Launching of Heavy War Ships and Ocean Liners. D. Pollock. Eng Rev–July 20. Serial. 1st part. 1100 w.

*506. The Shipbuilding Resources of Different Countries. Eng Rev–July 20. Serial. 1st part. 1100 w.

*548. Tubulous Boilers in the French Navy. (Extract). John K. Robinson (Results of personal observation of the working of the Belleville D'Allest and the Niclausse boilers). Am Eng & R R Jour–Aug. 4000 w.

*599. The Continental Steamboat Services (A popular description of steamboats on European rivers and lakes). Fairplay–July 26. Serial. 1st part. 1500 w.

*622. French War Vessels. Ill. (Descriptive). Eng, Lond–July 26. 1000 w.

MECHANICAL ENGINEERING

The Field Engine.

UNDER the title, "A New Departure in Steam-Engine Economy," *The Engineer* (July 5) editorially criticises a paper recently read before The Institution of Engineers and Shipbuilders, in Scotland, by Professor Jamieson, of the Glasgow and West of Scotland Technical College. The paper gave a description of the new heat engine invented by Mr. Edward Field, and a report of a test made with this motor, wherein it is stated that remarkable results were achieved. A description of the motor is quoted from Professor Jamieson's paper.

"A Roots blower, driven by the engine, draws fresh cold air from the engine-room, and forces the same through a series of heating pipes placed in the main flue between the boiler or boilers and the chimney. This heater, therefore, occupies pretty much the same position as a Green's economizer. The air was maintained, in my experiments, at a mean pressure of 1134 lbs. on the square inch, and delivered to the ends of the cylinder at a mean temperature of 553° F., and to the valve-casing jacket at about 380°. This hot air was admitted to the cylinder through special cylinder covers, each containing five inlet valves, which automatically opened inwards as soon as the exhaust steam commenced to escape. These valves continued open until compression commenced, being held close to their seats by light spiral springs. Consequently the whole internal surface of the cylinder was heated up to a temperature far exceeding that of the steam, thus preventing the possibility of condensation taking place within the cylinder. Under these circumstances I got the excellent result of 18.6 lbs. of steam per indicated horse-power per hour, from a single cylinder non-condensing engine, —a result which, as far as I can learn, has never been equalled by any other method of using steam in a single cylinder, and without subsequent condensation." Now, Professor Jamieson is a well recognized authority in steam engineering, and is known to be an accomplished engineer. *Prima facie*, the results asserted by such an experimenter would seem to compel acceptance; *The Engineer*, however, and not unreasonably, thinks some of the indications supplied by the indicator and the pressure gages are puzzling. Being thus, they lead to some question whether the results alleged are altogether trustworthy.

"The diameter of the cylinder of the engine tested was 19 in.; the length of stroke 3 ft. The mean indicated horse-power was 136.75; the brake horse-power was 104.6. . . . . The engine has double Corliss valves, one for admission at each end of the cylinder. But they are quite close together, and the incoming steam has to pass over surface cooled by the exhaust. The steam from the boiler passes through a superheater. This is not described, but appears to be a vertical cylinder traversed by vertical pipes, through which some of the hot waste gases flow while the steam fills the cylinder. There is not a specially free course from the boiler to the cylinder valve chests. Yet we find from the table of results the pressure by the steam gage on the boiler only varying between 112 lbs. and 115 lbs. The pressure in the cylinder given by the indicator varied between 112 lbs. and 115 lbs. Sometimes the initial pressure in the cylinder was higher than the boiler pressure. Very frequently the two pressures were identical. In no case was the valve pressure more than 1 lb. in excess of the initial cylinder pressure. This was certainly curious."

"Professor Jamieson makes no attempt to explain a circumstance which seems to be unique, at least under the conditions. Sir D. Gooch is said to have got a valve-chest pressure greater than the boiler pressure in a locomotive, but not, it will be understood, steadily greater. The result was produced only by the hammer action of the steam when the valve suddenly closed the admission port. It is a pity thst Professor Jamieson has said nothing in explanation; and it is a pity, because such a result—or, rather, the statement of such a result—tends to raise a doubt in our minds about the accuracy of the indicators. We are led to suspect that the springs were weak, and that the indicated power was apparently greater than it was in reality,—a suspicion strengthened by the large excess of the indicated over the brake horse-power. However, we may put this on one side, and take it for granted that Professor Jamieson's figures are right. Only then we are puzzled to know how the steam managed to find its way into the cylinder with sufficient rapidity to keep the admission corner of the diagram nearly square. Professor Jamieson very properly calls attention to the unusual shape of the diagrams. They are not at all like Corliss diagrams, but rather like those taken from a locomotive much linked up, the compression being enormous, while expansion takes place precisely down to the atmospheric line, and no lower. It has been said that it is more difficult to be absolutely last in an examination than absolutely first; and we cannot imagine anything more difficult than to make certain that the exhaust port shall open precisely at the moment that the pressure inside the cylinder and outside it are identical, and this not only when the engine was indicating full power, but at one-fourth power. Professor Jamieson is certainly justified in saying that the four fac-simile diagrams which he gives demand special attention from their unusual shape."

Without further following this criticism to its conclusion, we may say that *The Engineer* seems to us to succeed in showing that, under the conditions when the indicator diagrams were taken off, the cylinder contained a large quantity of compressed steam and air at the end of the stroke, and that the indicator would not and did not "account for all the feed water at the moment the admission port closed, which it would do, of course, if there had been no initial condensation." The results stated must be confirmed before they can be accepted with confidence by engineers.

Boilers and Boiler Settings.

A REVIEW of up-to-date practice in the setting of boilers is presented by L. Summers in *Electrical Engineering* for July. The gradual change in ideas regarding boiler settings that has taken place during the last 5 years is considered, not radical, but in the line of a gradual adaptation to the tendency toward higher pressures and greater economy in fuel.

The most noticeable change is increase of heating surface in proportion to grate area. Whereas a ratio of 30 to 1 was formerly considered good practice, we now have 45 to 1, 50 to 1, and in some cases even more than 50 to 1. An old rule was to make the ratio of grate area to heating surface twice the number representing the pounds of coal burned per hour, and it is still followed by some steam engineers.

There is also a tendency toward increase of the size of tubes. From 3 to 3 1/2 in. used to be the practice in stationary boilers; now 4-in. tubes are common. Area of chimney is now made about equal to total area of cross-section of tubes. Heights of chimneys are not so great since their areas have been increased. The strength of draft is now equal to about 0.5 to 0.75 in. of water. It is found that "the maximum power can be developed with this draft, and a consumption of from 20 to 30 lbs. of coal per square foot of grate obtained without the temperature of the escaping gases exceeding 500° F., while their average temperature at a moderate rate of coal consumption is below this." A chimney 100 ft. high, with the area above named, will usually give a draft of from 0.6 to 0.7 in. of water. "Many old rules are given for the proportion of chimneys. For instance, a common rule is that the height of the chimney shall be twenty times the diameter of flue; another rule, which is probably derived from the above, is that the height shall be twenty-five times the area of the flue. It is evident that these rules are not applicable to all conditions, and are entirely empirical."

The late practice of the Hartford Steam Boiler Inspection and Insurance Company is to make the width of the furnace 6 in. less than the diameter of the boiler, and to give the side walls a uniform batter, such as will leave a space of 3 in. between the boiler and the walls at the top, where the walls are run in to meet the shell. The heated gases are thus prevented from infringing against the side walls, and rise directly to and against the shell. "It also increases the volume of the combustion chamber, and provides for a more thorough mixing of the gases and a more complete combustion. The space of 3 in. between the shell and walls admits of inspection and cleaning, and also, in a great measure, prevents the lodgment of soot and ash. In place of the large combustion chamber beyond the bridge wall, almost all modern settings provide an inclined or curved flue. It is found that the tendency of the heated gases is to follow the boiler contour, and that, inasmuch as the increased space beyond the bridge wall has no tendency to produce a more thorough mixing of the gases, and the current is confined to the upper part of the chamber, the lower part adjacent to the bridge wall is not only useless space, but also allows an increased chance for radiation and leakage of cold air, as well as convenient corners for the lodgment of ashes and soot. By filling in this space and giving it a sloping bed, cleaning is greatly facilitated, as the cleaning door may be placed on a level with the floor and the refuse readily hoed out without even necessitating the cooling down of the setting. Another advantage is gained by lowering the cleaning door, as it is thus put below the direct action of the current of gases and does not receive the impingement of the flame."

Grates are now placed as near the boiler shells as the necessity of thorough combustion will permit. For anthracite coal 24 in. is the approved practice, while for soft coal 30 in. is the distance. These distances have been adopted by the Hartford Steam Boiler Inspection and Insurance Company.

A setting designed by Mr. James L. Ayre has been favorably received by western electric-lighting plants. In this setting a curved flame-bed is made to replace the former inclined bed behind the bridge wall, the curvature of the bed corresponding with the curvature which the flame naturally takes through the chamber after passing the bridge wall. A construction is also used which is thought to secure a more uniform distribution of the hot gases in the tubes. Much attention has been given of late to methods of setting designed to support the boiler in such manner that fissures will not occur in the setting, these allowing cold air to leak in and intermingle with the hot gases. Double walls with an intervening air space have been employed for this purpose.

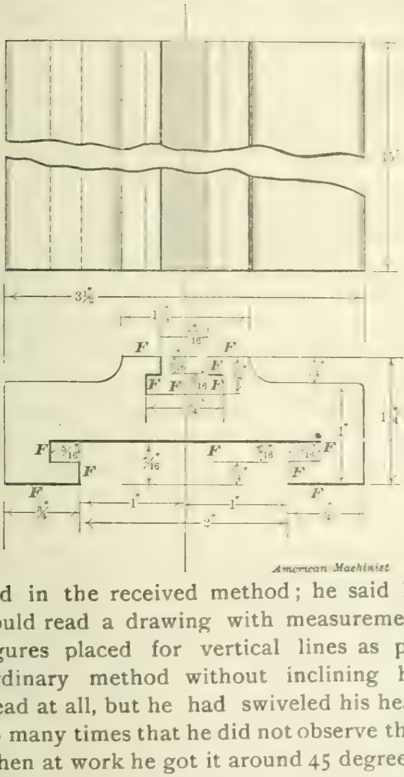
Figuring Drawings.

It has hitherto been the custom among draftsmen to figure drawings in such manner as to bring the figures into the horizontal position for reading off dimensions; the lines indicating the points between which the dimensions are taken must also be brought into the horizontal position. We have often mentally questioned the advantage of this convention, and we are glad that a practical mechanic and draftsman has brought the method under criticism. Mr. Francis W. Clough, in *American Machinist* (June 27), gives an illustration of a drawing so figured that both horizontal and vertical dimensions may be read without turning the sheet, and he gives very sensible reasons for preferring this plan in general practice to the old method. He says:

"The ordinary method reminds one of some proficient letter-writers, who, having filled all of the horizontal space on their paper, extend their manipulations on the vertical borders of the letter, encroaching on the regular line writing, and before they finish they get around on the top of sheet, sometimes bottom side up, sometimes right side up, until the receiver is often puzzled as to where to begin, how to read, and when he is done.

"The argument is sometimes offered that all figures should read from the same direction of sight as the indicating points designate. That is simply an argument; while the opposite simply replies that any dimension line having two terminating points, with an opening in the midway of said line to receive the figure, is equally intelligible whether the figure is one way or another, and more readily made in the drawing-room and read in the shop in the method illustrated.

"Some years ago a venerable pattern-maker objected to my method, and argued to me that there was a greater liability to mistakes, etc., in reading. I tried to show him that the greater liability to error existed in the received method; he said he could read a drawing with measurement figures placed for vertical lines as per ordinary method without inclining his head at all, but he had swiveled his head so many times that he did not observe that when at work he got it around 45 degrees; perhaps he had got that amount of lost motion in his neck joint. But I kept on making drawings the same way, and he kept making patterns from them, and you would be surprised to know how well he liked it after a little while. That man was in a rut on figuring drawings; but later he stood up erect, and looked directly in front of him, and read my drawings the same as he would read any other printing. There is a fitness, correctness, and ease in conveying properly all intelligence, and the more naturally it can be read and understood the more mechanical will it also be.



American Machinist

"The figure represents an ordinary square-tongue slide having a T-groove on the top side, 15 in. long, 3½ wide, 1¼ thick; the letter *F* designates what parts are to be finished, so that the pattern-maker can make the pattern, and allow for finish. The machinists can do the machine work from the same drawing, and read measurements from before them without trouble, and with less liability to read wrong than from a bias, twisting glance, as on ordinary drawings."

Weight of Shafting as Related to Economy of Power.

THAT shafting heavier than is required for the work to be performed (of course allowing a reasonable factor of safety) will consume and waste power through the friction of its superfluous weight hardly needs to be stated. The fact will be universally admitted, and its reassertion would be trite. It is, however, not so well understood that the weight of a shaft, while it will determine the static friction upon bearings whose coefficients of friction are known, does not alone determine the power which will be consumed in a unit of time in overcoming the static friction. Two other factors—the diameter of the bearing (or the circumference) and the velocity of rotation—influence the amount of power required to drive shafting. Weight being constant, the power required to perform the work of friction will be as the product of the diameter (or of the circumference) into the number of revolutions per unit of time. The total work in foot-pounds per hour due to any particular bearing will be the product of the coefficient of friction, the weight in pounds sustained by the bearing, the circumference of the bearing in feet, and the number of revolutions made by the shaft in 1 hour. To obtain the horse-power necessary to overcome this friction, the product may be divided by 33.000. Applying this rule, many would be astonished at the work so consumed throughout a large manufactory, wherein shafts and counter-shafts are numerous.

The *Boston Journal of Commerce* (July 6), discussing this waste, says that its reduction has been sought by the use of tubular shafting. Now, while a tube of a given weight is stronger than a solid round bar of the same weight, its diameter is greater, so that this plan amounts to an increase of one of the factors, while reducing another. Though one of these factors—the weight—may be decreased, the diameter, to gain equal strength, requires to be increased so much as to greatly neutralize the effect. This fact, taken in connection with the greater cost of hollow shafting, has prevented the use of the latter to any considerable extent. The *Boston Journal of Commerce* writer maintains that, in the designing of shafting, the factor of safety is made larger than necessary. He adds:

"Did any one ever hear of a light shaft breaking? The shafts that break off are always heavy, and usually become too heavy and non-elastic,—too rigid. A shaft that is elastic has some spring to it, and never breaks unless structurally defective; and many a broken shaft might have been saved, if it had been lighter and more elastic. Right here lies the solution to the problem. All shaftings should be made of the best and most elastic iron, and then it should be light in proportion. If the iron in a shaft possesses life and elasticity, as it should, comparatively light shafts would, with the greatest ease and safety, do the work now being done by thousands of heavy shafts in every manufacturing locality, and thus save thousands of horse power of now wasted force that could be applied to useful work."

To the question about breakages of light shafting we can answer affirmatively, and doubt not that others can do the same. But there are other questions besides liability to breakage that must be considered in designing shafting, which appear to have been ignored by the writer quoted. There is the question of size of bearings, so that they may run without heating, and of sufficient rapidity to prevent the binding of bearings in boxes and to avoid undue torsional yielding. In our opinion less power is wasted needlessly by undue weight of shafting in general practice than by imperfect alignment. There used to be excessive weight in pulleys, but in these days of careful designing we think this fault is not so common as it was a few years ago.

The Smith's Craft.

In the art of forging as developed in these later days of machines that not only work, but seem to work almost intelligently and consciously, *The Practical Engineer* says that "less thought, judgment, and intelligent manipulation are required" than used to be needed. This may perhaps be true of the operators who feed heated blanks to drop forging machines, but we cannot concede that die-making, the regulation of heat, the gaging of the strength of blows, and the selection of material for different kinds of work require less intelligence or less judgment than was required in the old-time forging. It is true that steel has largely superseded iron, and that much light work is now done under the drop-press with or without dies, and it is admitted that "iron requires more thought and judgment in working than mild steel"; but, while in this respect the demand for mind-work has lessened, it has rather increased on other lines.

A certain care and knowledge, and even some experiment, that once were required in working different kinds of iron have been rendered less requisite by modern methods, as our contemporary states. "Not only in such work as drawing down, upsetting, bending, arrangement of fibre, and general manipulation of this character is the difference of wrought iron and steel apparent, but also in welding, punching, and drifting. All these are more easily done in mild steel than in common wrought iron. The presence of scale in wrought iron will effectually prevent formation of sound weld. In mild steel, not over heated, a weld can generally be depended upon. Punching and drifting out are risky in reedy iron, opening out the grain, dividing the fibres, and producing cracks more or less wide according to circumstances; whereas mild steel can be punched and drifted with the utmost facility and with practically no risk, because it is homogeneous, without grain, and highly ductile." A certain skill of hand and eye which the old smiths required is undoubtedly becoming rarer from the introduction of machine forging. "Very heavy work used to be done well by building up with welds, which is now drawn down under hammer or press from solid bars or slabs. Not only does the strength of some classes of work of medium size suffer in consequence, but far less skill is demanded of the smith, less judgment, less precision of eye and hand,—less, too, from his helpers. Again, much good heavy work used to be done by a gang of men swinging sledges in concert, raining a rapid succession of blows upon a forging, or tupping with the monkey, or closing a large weld. This is now all past. In smaller work, too, numerous similar pieces are formed, or finished in dies or stamps, which have become almost necessary appendages to steam hammers and presses. Some of this work formerly afforded great scope for manipulative skill, and the older smiths could finish it with smoothness and accuracy, approximating to that of machine work. But relatively little skill is required when finish is imparted to dozens of similar articles in dies."

We do not share the regret in which our contemporary indulges at the decay of skill, which it regards as an evil. Better, more accurate, and cheaper forging is done by modern methods than by those whose decay is lamented. To regret these is simply to take a wrong view of evolution, and thus to acquire the idea that progress is retrogression.

The Machine Shop as an Educator for Molders.

In the *Foundry* for July M. H. Hansen asserts that "the rank and file of machinists have received a better education than molders," and that it is unfortunate "that molders are not better acquainted with the machine shop and machines." As to the assertion of inferior education on the part of molders, it rests solely on the assertion of Mr. Hansen, who does not back it with evidence. As a consequence of this alleged fact, it is stated that the machinist is able to converse on many subjects of which the molder knows nothing. Possibly the molder could also talk about some things of which the average machinist is ignorant, but this possibility does not seem to have occurred to Mr. Hansen. Yet there is some truth in what follows.

"The total extent of many molders' familiarity with the machine shop is geographical, and is acquired in the search for a good hiding-place to locate a bottle. Many a casting with a big N. G. can be charged to a want of information in regard to what it was intended for or the position it would occupy when assembled. Many molders will probably say they have no time to monkey around the machine shop, yet nearly every foundry has a few who may find several chances during the week to look through this interesting chamber. At recess, while some are playing ball, others watching them and spinning yarns, these are looking through the machine shop, inspecting castings here and there being finished. At the end of the year who are the best molders,—those that played ball, or those that investigated the machine shop? I say the latter by far."

A machine shop is a good school for anyone who has a receptive mind, and good perceptive faculties, and who is desirous of learning what may be learned there.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Engineering and Technical Journals—See Introductory.

The Machine Shop.

32. Use and Abuse of Belts. William F. Roberts (A popular and practical treatment of the subject). Sta Eng–June. 5000 w.

33. Drilling Holes (A practical talk on hand drilling). Sta Eng–June. 900 w.

69. Weight of Shafting (Treats of waste of power by superfluous weight of shafting). Bos Jour Com–July 6. 900 w.

We supply copies of these articles. See Introductory.

94. The Band Saw. John M. Richardson (Practical use of band saw). Am Mach–July 11. 1500 w.

157. Shop Tests of Locomotives, with Editorial (Report of committee appointed in 1894 to report on proposed tests of locomotives at Purdue University). Ry Age–July 12. 2500 w.

250. A Method of Casting Car Wheels. Ill. (Method invented by Mr. Joseph Carr of Wilkesbarre, Pa. Employs a hollow, instead of solid core. Superior results claimed). Ir Tr Rev–July 11. 1500 w.

303. Lignum-vitæ for Bearings, Crosshead Gibs, etc. (Practical experience with). T. McKim Chase. Am Mach–July 18. 800 w.

*311. Dies, Blocks, and Appliances for Engine Smiths. Ill. Joseph Horner (Practice of drop forging). Prac Eng–July 12. Serial. 1st part. 2300 w.

378. The Machine Shop as an Educator of Molders. H. Hansen (What the molder may learn therein). Foundry–July. 1400 w.

385. Calipers. A Mechanic (Suggestions for improvement in construction and use). Am Mech–July 25. 1800 w.

*489. The Craft of the Smith. Editorial (Differences between modern forging and that of the past, with reasons for present practice). Prac Eng–July 19 1500 w.

501. Submitting Drawings of Machines. Editorial. Ir Age–Aug. 1. 700 w.

513. Value of Degrees of Belt Contact. D. N. Ricker (An experimental determination). Power–Aug. 200 w.

Steam Engineering.

35. Compound Engines (Editorial. Analysis of the question " Which is the more economical in a non-condensing compound engine (ideal or real), 22 and 40 by 60 running at 70 revolutions per minute with 120 pounds pressure by gauge, to cut off one-fifth in both cylinders or one-sixth in the high pressure and one-quarter in the low?") Power–July. 1300 w.

36. Ratios of Expansion, Mean and Initial Pressures (Table for computing mean and initial pressures, points of cut-off, etc., with explanatory text). Power–July. 1500 w.

37. Valve Model for Horizontal Engines. Ill. (Descriptive of a model combining various standard types of valve gear, for the use of draughtsmen and designers). Power–July. 800 w.

38. Condensers. F. R. Low (Theoretical and practical). Ill. Power–July. 6000 w.

39. Single Plate Pistons. Ill. (Details of construction in designs for). Ry Rev–July 6. 1100 w.

75. Specifications for Boiler Tubes (Editorial. Points out a difficulty in the general adoption of standards for boiler tubes arising from varying local conditions; notwithstanding the standard is approved). Ry Age–July 5. 500 w.

92. Compounding—Its Thermal and Mechanical Advantages Under Proper Conditions, W. H. Booth. Am Mach–July 11. 1500 w.

96. The Development of the Experimental Study of Heat Engines. W. C. Unwin (Historical review). Sci Am Sup–July 13. 5200 w.

129. Fuels and Firing. Lord's Mag–July. Serial. 1st part. 1500 w.

130. Chimney Construction (Practical and popular). Lord's Mag–July. 2500 w.

131. Indicator Uses (Popular). Lord's Mag–July. 1500 w.

132. Engine Foundations (Practical and popular). Lord's Mag–July. 1500 w.

133. Main Steam Connections. Ill. (Practical and popular). Lord's Mag–July. 1300 w.

134. The Care of Boilers (Practical and popular). Lord's Mag–July. 1800 w.

158. Steam Carriages: Where are they Carrying Us? (Editorial on the recent races of steam wagons from Paris to Bordeaux. Considers such a contest yet impossible to America). Pro Age–July 15. 800 w.

*172. Steam Engine Trials (Editorial. General review of present status of knowledge, and present practice in testing steam engines). Engng–July 5. 1900 w.

*174. Locomotive Piston Rods. Ill. H. Rolfe (An important, practical discussion of the question of fitting piston rods to cross heads). Engng–July 5. 5300 w.

179. Some Ideas Concerning Boilers and Boiler Settings. Ill. L. L. Summers (Up-to-date practice). Elec Engng–July. 2400 w.

*208. Steam Engine Problems. (A critique of a criticism of Prof. Unwin's James Forrest lecture in the Engineer). Elec Rev, Lond–July 5. 1400 w.

*221. A New Departure in Steam Engine Economy. Editorial (A critique on Prof. Jamison's report of a test of the Field heat engine). Eng, Lond–July 5. 2300 w.

*273. Boiler Explosions. (Abstract of report for 1894 of the Chief Engineer of the National Boiler and General Insurance Co., Limited). Mech Wld–July 12. 1900 w.

*295. A New Type of Steam Motor. (Remarkable economy by use of super-heated steam in a motor designed by W. Schmidt of Aschersleben). Ir & Steel Tr Jour–July 6. 900 w.

*354. The Efficiency of Heating Surface in Steam Boilers (Theoretical discussion and review of experimental researches of Blechynden, Stromeyer, Durston and Fletcher). Engng, Lond–July 12. 1600 w.

*360. Clearance in Steam Engine Cylinders (Editorial. Anomalous effect of clearance). Eng, Lond–July 12. 1800 w.

404. Boiler Feed Waters; Their Treatment. W. D. Jameson (Mixture of sugars; the boiler a galvanic battery; deleterious action of oil in steam boilers). W Elec–July 27. 3000 w.

514. Valve Gears. Ill. C. W. McCord, Jr. (Principles of valve gear and applications of graphical methods in laying out valve gears of various types). Power–Aug. Serial. 1st part. 2800 w.

646. Drainage of Heating Coils and Steam

Pipes. Allehassett, in Louisiana Planter. Sci Am Sup–Aug 10. 2000 w.

*672. The Mechanical and Electrical Regulation of Steam Engines. Ill. John Richardson (A paper dealing with the practical results which can be obtained from a great variety of types of governors that have come under the author's personal observation, and the causes of their failure or success). Ind & Ir–Aug. 2. 6000 w.

Miscellany.

*2. Emancipation of Labor by Machinery. A. E. Onterbridge, Jr. (An old economic delusion exploded). Eng Mag–Sept. 3500 w.

13. Mechanics of the Ferris Wheel (With Stiff Spokes). I. P. Church. (Treats mathematically the inter-dependence between the stresses in the bars of a Ferris Wheel (with stiff spokes) and their elastic changes of length). Eng News–July 4. 700 w.

†19. Injuries to Workingmen from Defective Machinery (Mutual responsibility of employers and employed). San–July. 6000 w.

34. Fifteen Thousand Horse Power Reversing Rolling Mill Engine. Ill. (Descriptive). Power–July. 700 w.

41. Excavator for Sinking Cylinders. Ill. Clement F. Street (Descriptive). Ry Rev–July 6. 300 w.

42. A T-Square and Its Mountings. Ill. W. A. Gabriel. Ry Rev–July 6. 500 w.

†80. The Theory of the Air-Lift Pumps. Ill. Elmo G. Harris (A mathematical analysis believed to be the first attempt at such a treatment of the theory of the air-lift pump, with tables of results). Jour Frank Inst–July. 3300 w.

91. A Job of Foundry Work. Ill. (Describing moulding of 180 lb. bull-wheels at Deering Reaper Works, done at cost of 16 cts.). Am Mach–July 11. 2300 w.

93. A Horse-Power Planimeter. Ill. (Describes an instrument which reads horse-power directly from indicator cards). Am Mach–July 11. 800 w.

138. Who Invented the Rolling of Metals by Grooved Rolls? W. E. Durfee (Throws doubt on the general belief that the invention should be accredited to Henry Cort, and quotes Latin and Italian authorities which seem to carry the invention back to the early part of the 17th Century). Bul Ir & Steel Asso–July 10. 700 w.

165. Application of Blast Furnace Gases to Gas Engines. Abstract. W. H. Watkinson (Describes what the author considers a much more efficient method of utilizing the thermal energy of these gases). Am Mfr & Ir Wld–July 12. 600 w.

*211. The Red Car Boiler Explosion and Its Influence on Gas Engine Practice. W. H. B. Elec Rev, Lond–July 5. 800 w.

*220. Steam, Oil and Gas Engines at the Royal Agricultural Show. Ill. Eng, Lond–July 5. 3600 w.

*222. Good Enough (Why so many patents are taken and why so many prove unprofitable). Eng, Lond–July 5. 1400 w.

304. Gas vs. Electricity. William Cox (Comparison of results in use of motors and Welsbach system, with electricity for illumination). Am Mach–July 18. 1500 w.

305. The Story of a Great Invention. (The Appleby Twine Binder). Ill. H. L. A. Am Mach–July 18. 5600 w.

376. A Visit to the Foundry of William Sellers & Co., Incorporated, Philadelphia. Ill. Foundry–July. 2200 w.

377. Pressure on Molds. Herbert M. Ramp (A practical discussion of an important point in foundry practice with 6 tables of pressures under different conditions). Foundry–July. 1800 w.

379. Foundry Heating and Ventilating. Foundry–July. 400 w.

384. Experiments with Foundry Iron and Aluminum. C. G. Taylor (Effect of aluminum when added in the commercial way in the foundry, with table of results). Am Mach–July 25. 1300 w.

386. The Bicycle vs. the Horse. "Quirk" (Computation of work required to propel bicycles). Am Mach–July 25. 1200 w.

387. Design of Water Wheels. Samuel Webber (Notes relating to introduction of various turbines and their inventor). Am Mach–July 25. 800 w.

405. New Forms of Friction Brakes. Ill. W. F. M. Goss. Safety V–July 15. 2500 w.

406. The Power Absorbed by Rope and Belt Transmission (Experiments made by the Société Industrielle du Nord de la France to determine comparative efficiency). Safety V–July 15. 2200 w.

500. Renewing Old Steel Rails (Describes a process and plant). Ir Age–Aug. 1. 1200 w.

515. The Prevalent Method of Calculating Water-Power and for Testing the Efficiency of Water Wheels Produces Erroneous Results. F. M. F. Cazin (Compares and discusses equations of Cazin and Trautwine, for computing water-power). Power–Aug. Serial. 1st part. 2000 w.

616. Adiabatic Curve Construction—Uses of Logarithmic Section Paper (Describes a method of drawing adiabatic curves whereby there seems to be a great saving of labor effected). Am Mach–Aug. 1. 1600 w.

625. Fly Wheel Arms. Ill. C. V. Kerr (A mathematical discussion). Am Mach–Aug 8 2500 w.

644. The Horseless Carriage Races (Rules of the international, English and American races arranged between the *Engineer* (London) and the Chicago *Times Herald* and to take place Nov. 2, 1895). Sci Am–Aug. 10. 1000 w.

*669. Vegetable Lubricating Oils (Principles involved in judging of their authenticity, etc). Irm–Aug. 3. 2200 w.

*673. Hydraulic Stoking Machinery and Labor Saving Appliances. Andrew S. Biggart with Discussion (Changes due to mechanical appliances, especially in gas works). Ind & Ir–Aug. 2. 5000 w.

MINING & METALLURGY

Fighting a Coal-Mine Fire.

A GRAPHIC account of the remarkable struggle to overcome the fire which occurred October 8, 1894, in the Luke Fiddler colliery, near Shamokin, Pa., is given by Mr. Baird Hallerstadt in the *Colliery Engineer* for August. The workings in this mine are very extensive, there being 28 miles of gangways, while connected with them are the workings of two large active collieries and one abandoned one. The fire originated through the carelessness of a carpenter who used a naked light, contrary to orders, while repairing an air-box. The flames rapidly spread, destroying the fan and consequently stopping all artificial ventilation, and soon caught the heavy timbering of an old underground engine station and the timbers throughout the adjacent workings. A heavily-timbered shaft, once on fire, formed a vent for the draft, and the whole became a roaring furnace, likened by the author to a veritable Inferno. This is what confronted the first party of heroic miners, led by the superintendent and an inspector, when they reached the spot, advancing with pipe and hose to battle with it. There were then sixty men in various parts of the mine, and to rescue them became the first effort. Volunteers were called for, and, as always happens in such cases, there was no hesitation about responding. Three relief parties were formed, who were so fortunate as to reach and remove all but two of the miners under ground. Two others, found and directed toward safety, became bewildered and lost their way. The city firemen and the miners made desperate efforts to subdue the fire by direct means, sending water down through rope holes which had been drilled from the surface plant to connect with the old shaft, and also through two 3-in. lines of gas pipe run down the new shaft and turned toward the fire. But soon the smoke and the terrific explosions of fire damp precluded all chances of success in this way, if any had existed. There remained but one thing to do,—flood the workings, not only to save this mine, but also the other valuable collieries connected with it. There were still four human beings below ground, and, had there remained the slightest probability of their being alive, the plan of flooding would not have been adopted. After a consultation of mine officials and State mine inspectors, at which every point was carefully weighed, the superintendent at the outset declaring that he would sacrifice the entire colliery rather than flood it if the slightest hope of rescue of the men alive or dead remained, it was determined that no such chance existed. Preparations were at once made to drown the workings, and all known openings through which air could enter were battened down with plank and clay. It was also decided to fill up the burning underground shaft with culm run in with water through the rope holes. A track was laid to the culm bank, pipes run to the pump, and 4 days after the fire started the slushing began. Ten days later it was completed, after sending down 2311 carloads, weighing 4622 tons. To drown out the colliery the waters of Coal Run were sent in through an adjoining mine, two 8-in. pumps handling this water, while what water could be spared from the town supply was also used. It was necessary to build two dams,—one in a tunnel, the other in the shaft. Details of the construction of these stops are given by Mr. Hallerstadt, an interesting feature of the tunnel dam being the insertion of a large pipe serving as a manhole through which a man could pass to make examinations without the necessity of breaking through the dam itself. It took 3 months to fill the mine to the degree desired. After the water had been left standing what was thought to be a sufficient time, the mine was examined and found not to contain a spark. Water standing above the tunnel level was then drawn off through the pipes in the dam. To remove the lower water, pumps with a capacity of 7,000,000 gallons per day were set up, supplemented by baling tanks raising 3,000,000 gallons daily. It was expected that the mine would be clear on August 1, —about 6 months after beginning the work of removing the water.

Economies in Coal Mining.

IN the introduction to a paper on the distribution of power in collieries, by Mr. L. B. Atkinson, read before a recent meeting of the South Wales Institute of Engineers printed in the *Colliery Guardian* of August 2, the author makes some very pertinent observations on the present situation, as to relation of costs to product, in English coal mining as contrasted with that in other industries. His view is rather pessimistic. Speaking from experience of some years, he declares that the opinion has gradually been forced upon him that there is a very large margin of economy in wages and fuel to be effected. This he ascribes to the fact that economies which are studied and made use of in other engineering enterprises and in manufacturing are considered in coal mining rarely, or, at most, only in a minority of cases. This may seem a rather sweeping assertion, but Mr. Atkinson supports it by adding: "This broad fact must appeal to every mind, that, whereas in almost every manufacturing process or industrial operation the product per man has probably doubled and the consumption of fuel has been halved within the last 15 years, in coal mining the product per man has been practically stationary, and the cost of fuel per ton raised probably nearly so." To the explanation sometimes offered,—that this is due to the stringency of mine legislation,—he answers that legislation has also largely affected other industries, and that therefore the result cannot be altogether attributed to this cause. Without enumerating all the causes which might be effective, the author states that, broadly, it appears to him that what is needed in coal mining is what has been done in every other department of industry,—namely, the lowering of the cost of labor and of material per ton by increasing the product per man and per pound of fuel. In brief, Mr. Atkinson's scheme involves the following means: (1) improved organization, both in working, and more especially in the original laying-out of the system of working, a colliery, and in the means for doing it; (2) more supervision underground by well-informed mining and mechanical engineers; (3) the greater use of mechanical power instead of human and horse power, and more economical production of that power. "In short," says the author, "substitute brains and mechanical power for human labor." It is the third class of economies that he especially deals with in the paper under review, but lack of space forces us to neglect the practical details. It will be noticed, however, that what Mr. Atkinson says in a general way as to coal mining applies to other branches of mining as well.

Mining Leases.

CUSTOMS vary widely in various parts of the world as to the arrangement entered into between lessees and owners of precious metal mines. The general idea of the system originated in the "tribute work" of copper and tin mines in Cornwall, but, as applied to gold and silver mines, there are naturally many variations. Mr. Francis F. Freeland's notes on the practice in the Rocky mountain region, communicated in a paper read before the American Institute of Mining Engineers, and the specimen examples he gives, will prove suggestive to mine-owners and miners elsewhere. In the west there are many mines worked in patches by lessees, to say nothing of other cases where the whole mine is leased outright. In the former case the company has its own foreman or inspector, and usually employs engineman, pumpman, and perhaps other workmen. Mr. Freeland cites cases in which the company advances a "footage," amounting to a third or a quarter of a fair contract price, to start a lessee having no capital and no ore in sight, enabling him to purchase supplies, etc.; and other cases where, for the same purpose, the company takes an interest in its own lease, advancing its share and getting it back, in addition to the tribute rate, when the ore is sold. Another help rendered by the company is to do the permanent dead work, in order to insure good workmanship, though a certain amount of development work is required also of the lessees. The author states that it is the common custom to give leases for six months, on a strip of vein 150 ft. long and from level to level. The company sells the ore.

Mr. Freeland considers the lease system especially suited to narrow veins of good grade, where careful placing of the shots is required to keep the ore clean and to save it all; and he rather grimly remarks—perhaps from experience—that it has advantages in a district controlled by a strong labor organization. He says that, as the workmen are interested in the product, they require less watching, no unnecessary dead work is done, and the minimum amount of supplies is consumed; that, with careful inspection, many mines can be systematically opened in this way, with profit to the owners or small danger of heavy losses.

There is much to be said for and against leasing. Some managers object to it because they think that, as a rule, the mine is left in bad shape as to supports and generally ragged. There is another consideration: Mr. Freeland assumes the case of companies having some working capital, but it also often happens that mines are leased simply because the owners are unable to work them themselves, while lessees better provided are willing to take chances of finding ore.

A form of contract is appended, together with a scale of royalties on silver ore, showing percentage rates for various grades. The scale runs from 10 per cent. on ore containing less than 20 ounces up to 70 per cent. on ore containing over 250 ounces.

The Dry Process of Gold Crushing.

If our valued London exchange, the *Mining Journal*, paid more attention to metallurgical practice in the United States, instead of almost confining its observations to the Transvaal and Australia, it would not have fallen into the error of assuming (as it does in its issue of July 20) that dry-crushing stamp batteries are a new thing. Such batteries have been in use for 30 years, and in great number and large capacity. True, they were used for silver ores, but, so far as the crushing is concerned, there is no difference. Before smelting took the lead, and while silver was a more profitable product, nearly half of the silver produced in the United States was extracted in mills having dry-crushing batteries and using the chloridizing-roasting-amalgamation process. However, as to the dry-crushing of gold ores the *Journal* has much of interest to say. It calls attention to the fact that in many parts of the world—particularly in Central and South America, India, and lately in West Australia—the profitable working of [some] gold and other mines is simply prevented by lack of water for the batteries. It goes on to say that "the objections urged against dry-crushing are the production of excessive dust, and the difficulty of substituting other methods of gold extraction for wet amalgamation by means of mercury over the plates. So far as the dust difficulty is concerned, it may be met by discarding the stamp battery altogether, and using machines with inclosed crushing gear, either in the form of revolving balls or rolls. But, apart from the mechanical difficulties which attach to these appliances, mining engineers have, as a body, a strong preference for the stamp battery as a means of fine crushing for ores. The dry crushing movement has certainly taken a strong step forward since it has been proposed to adapt the ordinary type of stamp battery to it. This is done by means of pnuematic tubes which convey the pulverized ore from the mortar boxes to cyanid vats, and which prevent the escape of the clouds of dust that have been the chief obstacle to the adoption of dry crushing in the past." Now, in dry-crushing silver mills this trouble has been met by closing in the mortars and removing the crushed ore by screw conveyor or fan in boxes or pipes, connected with an elevator if necessary.

As to the subsequent treatment of gold ores after crushing, the *Journal* remarks upon the difficulty of amalgamation. In the method referred to the ore goes at once to cyanid vats, and treatment over plates is of course inadmissible. The *Journal* well remarks that there are classes of ore which do not lend themselves to treatment of this kind; it also dwells upon the advantages of amalgamation, either alone or as an intervening stage between the battery and the cyanid vats. It gives due weight to the difficulties of the final metallurgical methods, but says that the recent (?) successful application of the dry process marks a most useful advance. There are, of course, many other machines besides the stamp battery for dry crushing, —rolls, grinders, Chile mills, and a host of other pulverizers. It might also be observed that, though water for crushing may be dispensed with, a mill can not be run wholly without it, as there must be water for the boilers, cyanid vats, if any, and other minor purposes.

Prospecting with the Diamond Drill.

AMONG several topics touched on in "Notes on Mining," a contribution to the *School of Mines Quarterly*, Mr. Richard A. Parker makes some practical remarks on the use of the diamond drill. Too much reliance, he thinks, must not be placed on its results in prospecting metal mines, but these must be supplemented by a close study of the form and nature of the known ore bodies of the district. In coal regions the warning has not the same force, for very obvious reasons. In the first case the lenses or deposits have dips and pitches, which, together with the line and angle at which the drilling is done, should be accurately plotted. To plot the drill hole accurately, it is not sufficient to take the direction of the hole near the surface; the fact that the rods may change, and probably have changed, must be considered. A great deal of money has been spent in proving that the results of diamond drilling are at times deceptive. Confirmatory holes should always be drilled where there is the faintest possibility of being misled by the results of drilling as shown by the original cores.

In sending down water to cool the bit and borts and wash the detritus from the cutting edge and send it to the surface, a small hand pump is used, sending the water down through the hollow rods, core barrel, and core lifter. In dense rock there is no loss of water, but in broken strata it may run off. Mr. Parker explains the necessity of making the leaky seams watertight, which is done by sending down paper cartridges of bran, plaster of Paris, or hydraulic cement, which are broken by a rod let down for that purpose and the contents rammed into the crevices. After allowing this material to harden or fill the crevices, drilling is resumed.

Another useful hint brought out by the author is the necessity that the engineer in charge of an exploring party should be acquainted with the nature and peculiarities of the diamonds themselves. After describing these he adds that old stones, weighing a karat to a karat and a half, are worth far more than new ones of the same weight, because they have been tested, and also because the loss occasioned by the wear of sharp points or angles is obviated. Therefore, worn stones of suitable size are to be purchased in preference to new ones.

Canadian Nickel Mines.

ACCORDING to an article in the *Iron Age*, the mine at Sudbury, Ontario, produced more nickel last year than in any previous year. Still, the quantity does not seem large, in view of the prospective demands for new utilizations, especially in alloys. The official figures stated that 112,037 tons of ore were mined and 87,916 tons were smelted. The nickel contents of the matte produced amounted to 2570½ tons, copper 2748 tons, and cobalt 3¼ tons. The value of the nickel was $612,734. There are five companies at work on seven locations. Since 1888, when operations began, the total production of nickel has been about 10,000 tons, and of copper about the same amount. It is stated that the Canadian mine owners have not made as large profits as they expected. This has been due to unsatisfactory prices for the product. In 1876 the price was $2.60 a lb.; but it fell considerably on the opening of the mines in New Caledonia, and later the prospect of a heavy output from the Sudbury mines themselves still farther reduced it, so that in 1894 the average was 86¼ cents. The cost of production is heavy, the matte produced on the spot having to be shipped to the United States or Europe for the extraction of the nickel, copper, and cobalt contents. On the other hand, all the coke used in smelting comes from Pennsylvania. A royalty of 3 per cent. on the nickel and copper was imposed in 1891. The average tenor of the Sudbury ore is not as high as that of the New Caledonia ore, which runs 5 to 6 per cent. nickel. Expectations rose to a high pitch in 1890, when 4500 tons of matte were purchased at Sudbury by the United States navy department for making nickel steel for armor, etc., and a temporary boom set in, which resulted in disappointment,—the main reason being the small percentage of nickel (2½ per cent.) used in that alloy. There are, however, other new metallurgical uses, besides the old and steady demand for nickel in plating.

The Canadian nickel region is a large one, extending from the western extremity of the north shore of Lake Huron to the boundary of the province of Quebec at Lake Abbitibbi,—a distance of over 300 miles, with a width of 75 miles; and during the nickel excitement there was much speculation in nickel-bearing lands, or those supposed to be such. The supply in the neighborhood of Sudbury is known to be immense.

Definite Combination of Alloys.

THE distinguished French engineer and metallurgist, M. H. Le Chatelier, recently read a paper on this subject before the Academie des Sciences in Paris, in which he said that, while definite alloy combinations are admitted by chemists, yet, besides brass and bronze, few particular cases are cited in the books. Further, the author holds that, of all the many combinations of metals experimented with, few are of interest from a scientific or practical point of view, because investigators have mainly directed their attention to physical rather than chemical characters and because the physical properties have given rise to somewhat contradictory conclusions.

The special alloys investigated and described by M. Le Chatelier are those of copper-tin (bronze), copper-zinc (brass), aluminum-copper, and chrome-zinc. His general conclusion as to definite combinations of metallic alloys is that they can be obtained by using an excess of the more attackable metal, and attacking the resulting alloy by an appropriate reagent. The definite alloys are hard and easily broken, and possess none of the malleable properties of the various metals of which they are built up. This appears to be the author's test of definiteness of composition; in other words, the physical properties are referred to as a proof. In the examples given the observed and the theoretical percentages are stated.

Gold-Mining Profits.

IT is of doubtful utility to attempt to compute average costs in precious-metal mining for all or even a considerable number of mines, since the results vary more widely in individual cases than in any other industry, and it is impossible to obtain the data necessary for the calculation, so that only a few particular instances can be cited, while for all only general qualified statements can be offered, and even these must be accepted with reservation. However, *Mining Industry* (Denver, July 25) editorially claims that gold mining in Colorado at the present time "pays a higher percentage of profit than any other productive enterprise in the world," and that in one case the cost of producing gold "is not to exceed 5 cents for $1." In another "a dollar costs 25 cents," and "in scores 50 per cent. or more of the product is net profit." "From the declared dividends of the incorporated gold-mining companies we know that, if they were the only ones which made profits, over 12 per cent. of the total [Colorado] gold product is profit, and, of the product of the incorporated companies only, over 31 per cent. is net profit." It is stated that only twenty-one gold-mining companies in Colorado declared profits, while there are about 300 gold mines in that State which yielded something, more or less. This looks like a pretty substantial showing, but the *Industry* fails to say anything about the failures and idle or abandoned gold mines. All the same, it is a most creditable showing as it stands, and it is gratifying to learn that Colorado is recovering from the depression in silver mining by its intensified interest in gold mining,

Ward Gold District, Colorado.

WARD district, Boulder county, Colorado, is by no means a new camp, and on that account perhaps attracts less attention than some of its younger rivals. Gold Hill and Copper Rock, in its immediate neighborhood, and Cripple Creek and other gold-mining districts elsewhere in the Rocky mountains, have been the scene of much excitement and mining activity, while Ward has remained a quiet, though steady, producer. A correspondent of the Denver *Mining Review* describes the camp and its leading mines in the issue of that paper for June 7, with illustrations of some of the works. The gold belt is about 4 miles wide and contains four principal and parallel lodes. The ore is gold-bearing chalcopyrite and pyrite, and differs from the tellurid gold ores of near-by districts. Under present conditions this ore can be mined and treated much more cheaply than formerly, a tenor of $4 per ton being aid to pay. Still, the ore is not wholly free milling, but requires concentration after amalgamation. The principal mines on the Columbia vein are the Utica, Boston, Number 5, Columbia, Ni-Wot, Madeline, Teller, Sullivan, and DeWitt. The Ni-Wot, once a heavy producer, is still earning $200 a day, while the Utica produces $500. Altogether these mines have yielded several million dollars. Another important group is in Spring gulch. The correspondent considers the Modoc as at present the most interesting mine of the district. It lies apart from the other principal veins, and has long been worked in good, but rather refractory, ore. Its mill contains the usual crushing plant, amalgamating machines, and belt vanners, and a cyanid plant is about to be added to treat the concentrates, hitherto shipped to smelters. Other mines and mills of the district are mentioned favorably.

The Chemist and the Blast Furnace.

"THE word chemist," writes Prof. Wm. B. Phillips in the *Engineering and Mining Journal*, "is employed in its widest signification [that is, in connection with furnace work], for the educated chemist is something more than a mere analyst. . . . If iron brokers can afford to build and equip a chemical and testing laboratory and engage a competent man to take charge of it [as has lately been done], how much more does it behoove the maker of the iron to see to it that the product, as it leaves his furnace, shall be as nearly perfect as it is possible to make it?" Besides the need for chemical study of iron intended for steel making, Professor Phillips points out that there is now a tendency to demand that certain grades of non-bessemer iron shall have a definite composition, variable within certain limits, it is true, but conforming to certain specifications. "In the grading of ordinary foundry, mill, and forge iron the need for the chemist is so patent that it is needless to discuss it. With uniform stock there is uniform iron, with varying stock varying iron." These variations are often quite beyond the skill of the ordinary grader, and Professor Phillips with reason asserts that the solution of the whole matter lies with the chemist. "If need be, let him have the furnace for his laboratory and the foundryman as chief assistant, and let them work it out. In nine cases out of ten these two can arrive at the cause of the trouble, and find a remedy for it."

THE *Engineering and Mining Journal* says that a bill now before the Canadian Parliament providing for the payment of a bonus on ores smelted, will probably pass. It appropriates a sum not exceeding $30,000 per annum, for 5 years to be paid for all ore smelted, at a maximum of 50c. per ton, smelters blown previous to July 1, 1896, only to participate.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy.

*8. The Revolution in Steel-Making. William Metcalf (Importance of the open hearth process). Eng Mag–Sept. 3000 w.

25. Tin Plate Production in this Country (Statistics, quarterly list of tin plate works in United States and list of brands of tin and terne plates made in United States). Met Work–July 6. 2000 w.

27.—$1.25. Report on the Loss of Gold in the reduction of Auriferous Veinstone in Victoria. Ill. Henry Rosales (With recommendations as to improvement, especially dressing of slimes). 65 pgs. 13 × 8″.

30. The Micro-Metallography of Iron. Ill. Thomas Andrews (Three systems of crystallization. Temperature. Measurement of crystals). Eng & Min Jour–July 6. 1300 w.

70. Sulphate of Ammonia Production at Blast Furnaces (Record of economies at Scotch furnaces). Am Mfr & Ir Wld–July 5. 700 w.

97. Molten Metal by Railway (Steel ladles transported five miles). Sci Am Sup–July 13. 800 w.

110. Annual Mint Account (Operations of San Francisco Mint, 1894–5). From San Francisco Chronicle. Min & Sci Pr–July 6. 1100 w.

141. The Concentration of Auriferous Sulphides in California. Ill. W. H. Storms (Tailing and slimes concentrated by vanners, sizers and canvas tables). Eng & Min Jour–July 13. Serial. 1st part. 2800 w.

143. The Ropp Straight-Line Furnace. Ill. (Long reverberatory; mechanical rabbling). Eng & Min Jour–July 13. 900 w.

166. Blast Furnaces July 1, 1895 (Statistics in detail. Editorial comment). Am Mfr & Ir Wld–July 12. 600 w.

*224. Reduction of Alumina, etc., by Hydrogen (Apparatus; method). Chem Tr Jour–July 6. 300 w.

*255. Pyrometers for Measuring High Temperatures. Ed. Deny (Abstract. Describes types; mode of using). Col Guard–July 5. 2000 w.

274. Production of Pig Iron in the United States in the First Half of the Year 1895; with Editorial (Detailed statistics). Bul Ir & St Asso–July 20. 1000 w.

*324. The Electrolytic Deposition and Reduction of Copper (Some practical experiences on a commercial scale. Summary of papers by E. Jensch and E. Cohen). Elec Rev, Lond. July 12. 1400 w.

365. Charcoal Iron. R. W. Raymond (Outlook). Eng & Min Jour–July 20. 500 w.

412. The Open Hearth Plant and Plate Mill of the Illinois Steel Company. Ill. (Details; construction). Ir Age–July 25. 2400 w.

413. The Increasing Production of Pig Iron (Encouraging outlook). Ir Age–July 25. 600 w.

*414. Cyanide at Pambula (Working method). Aus Min Stand–June 15. 750 w.

*415. Barrier Sulphides (The Banfield Process). Aus Min Stand–June 15. 700 w.

433. Pig Iron Production This Year (Analysis of half-year's returns). Am Mfr & Ir Wld-July 26. 600 w.

436. Iron Making in Virginia. H. S. Fleming (Cost of producing pig iron). Mfrs' Rec–July 26. 1500 w.

*472. The Broken Hill Problem (Sulphides and their treatment). Min Jour–July 20. 6500 w.

525. The MacArthur-Forrest Patent Commission (Testimony, Mercur case). Min & Sci Pr–July 27. 1200 w.

609. The Outlook for Charcoal Iron (Editorial. Competition with coke iron). Ir Tr Rev–Aug. 1. 900 w.

614. Before Bessemer—and After (Editorial. Recent process). Ir & Coal Tr Rev–July 26. 850 w.

*634. Application of Blast Furnace Gases to Gas Engines (Draws attention to a more economical and efficient method of using the thermal energy of these gases than has hitherto been employed). Col Guard–July 26. 800 w.

*639. Critical Notes on the "Sulman" Processes of Gold Extraction. W. Bettel (Mr. Sulman uses a cyanogen-yielding substance in presence of potassic or sodic cyanide to effect solution of gold and silver, instead of atmospheric oxygen, claiming that solution of precious metals by haloid compounds of cyanogen in presence of a solution of cyanide is infinitely superior to the MacArthur-Forrest process). Aus Min Stand–July 6. 2700 w.

642. The Basic Bessemer Process. F. E. Thompson (Alleged proof that there is nothing inherent in the basic Bessemer process to prevent the making regularly of good steel of soft quality for structural and other purposes). Ir Age–Aug. 8. 2500 w.

†658. On the Study of Slags from Lead Furnaces with the Object of Producing Liquation or Crust Effects. Joseph Struthers (An important research with extensive bibliography of the subject). Sch of Mines Quar–July. 2000 w.

662.—$1.50. Notes on Manufacture and Properties of Malleable Cast-Iron. H. R. Stanford (Written for the purpose of arousing interest and evoking discussion on this important industry. Gives personal experiences and tests with tabulated results). Tr Am Soc Civ Eng–July. 5800 w.

Mining.

9. *Ontario Drain Tunnel and Electric Plant C. R. McKay. (A work of interest to electrical and mining men). Eng Mag–Sept. 3000 w.

29. The New Comstock Enterprise. Dan De Quille (Cor.—Description of Brunswick Code. Its re working). Eng & Min Jour–July 6. 1600 w.

102. Iron Prospects in Southwest Virginia (Corr. Description ; favorable outlook ; freight statistics). Ir Age–July 11. 1800 w.

109. The West Side Lode. Ill. (Prospects west of main Comstock lode). Min & Sci Pr–July 6. 1600 w.

*111. Iron Ore Mines of Elba (History ; geology ; method of working). Kuhlow's–July 3. 6900 w.

*112. Mining Explosives (Experiments with safety explosives). Kuhlow's–July 3. 600 w.

*120. Rock Drills. What Constitutes an Efficient and Durable Drill (Requirements ; use and care of power drills). Col Eng–July. 3600 w.

*121. Electrical Mining Machinery. Ill. (Hauling, pumping, and drilling plant, Mt. Lookout Colliery). Col Eng–July. 1000 w.

*122. A Mine Fire Extinguished. Ill. Baird Halberstadt (Bulkheads and partial flooding). Col Eng–July. 1500 w.

*123. Ventilation of Mines (Mathematical discussion. J. T. Beard's book). Col Eng–July. 600 w.

*124. Mining Explosives (Effect on gas and dust in collieries ; combustion products). Editorial. Col Eng–July. 800 w.

*125. The Examination of Candidates for Certificates as Mine Foreman (Answers). Col Eng–July. Serial. 1st part. 1600 w.

*126. Electric Coal-Cutting at Glencleland Colliery (Extracts from paper by George Mitchell before the Mining Institute of Scotland. Cutters ; working results). Col Eng–July. 1200 w.

142. The New Mining Law of Idaho (Full text). Eng & Min Jour–July 13. 1800 w.

164. Mine Locomotives with Secondary Batteries. F. Combessedes (From Bulletin de la Société de l'Industrie Minerale. Details; working costs). Am Mfr & Ir Wld–July 12. 900 w.

213. The Great Newhouse Tunnel. Ill. (To tap Gilpin County mines ; present condition). Min Rev–July 12. 1100 w.

*218. Some Electric Mining Plant. Ill. (Colliery power plant ; hauling and hoisting engines; 3-throw pump). Eng, Lond–July 5. 900 w.

*230. The African Golconda (History's discovery). Fairplay–July 5. Serial. 1st part. 1800 w.

*244. Some Australian Minerals (Antimony, bismuth, platinum, chrome, manganese, plumbago). Ir & Coal Tr Rev–July 5. 600 w.

*246. Rio Tinto Mining Company (Commercial outlook ; iron and copper products). Editorial. Ir & Steel Tr Jour–June 29. 500 w.

*251. The Monmouthshire Coalfield. M. E. (General description ; methods of working). Col Guard–July 5. Serial. 1st part. 1500 W.

*252. Pumps and Pumping Machinery for Collieries and Mines. Ill. Philip R. Björling (Formulæ for duty ; describes lift pumps). Col Guard–July 5. Serial. 1st part. 2300 w.

*256. The Breithaupt Mining Theodolite. Ill. (Trans. from La Revue Technique. Details). Col Guard–July 5. 1800 w.

†297. The SukKur Petrololeum Borings (Failure ; geological prospecting). Ind & East Eng–June 15. 500 w.

346. Coal Deposits of Kachemak Bay, Alaska (Important discovery). Min & Sci Pr–July 13. 900 w.

*350. These Golden Nineties. D. H. Wheeler (Unexampled increase in the output of gold). Chau–Aug. 2400 w.

*361. Rent and Royalties in Leases of Mines (Legal questions ; English law). Col Guard–July 12. 3200 w.

364. The Coal Fields of West Virginia. Ill. Jed Hotchkiss (Geological). Am Mfr & Ir Wld–July 19. Serial. 1st part. 3000 w.

366. The Dipping Needle and the Miner's Compass. Ill. William Allen Smith (Use in iron mining). Eng & Min Jour–July 20. 3500 w.

402. Mine Managers and Workmen (Editorial. Qualifications contrasted). Min Ind & Tr–July 18. 1000 w.

403. Two Great Mining Properties. Ill. (Hope and Katie Mines, Mont.) West Min Wld–July 20. 900 w.

419. Debris Commission's Report (Extracts). Min & Sci Pr–July 20. 700 w.

420. The Trail Creek Country. Clarence King (Important new gold and silver field). Min & Sci Pr–July 20. 1400 w.

421. The Sultepec Mining District. C. (Silver ; lead). Cor Min & Sci Pr–July 20. 1000 w.

445. Zinc and Lead Mining in Missouri and Kansas in 1895. J. R. Holibaugh (Brief review). Eng & Min Jour–July 27. 600 w.

*469. The Russian Oil-Industry (Statistics). Irm–July 20. 400 w.

*471. The Present and the Future of Coolgardie (Favorable account). Min Jour–July 20. 2600 w.

*473. The Output of the South African Republic in 1894 (Review report of the Minister of Mines). Min Jour–July 20. 1200 w.

*482. The Right to Work Mines to the Injury of the Surface (Litigation in England). Col Guard-July 19. 2500 w.

*484. The Timsbury Colliery Explosion (Gas ignited by shot). Col Guard–July 19. 4300 w.

*485. A Pass-Bye in a North Wales Mining Shaft. Ill. W. H. Wilson (Two cages in one compartment). Col Guard–July 19. 800 w.

*486. The Prevention of Colliery Explosions in Austria. Robert Lamprecht (Precautions in blasting and lighting). Col Guard–July 19. 1200 w.

*490. Improvements in Water-Spraying Apparatus for Coal Mines. Ill. (Abstract of paper by W. Saint, Manchester Geol. Soc). Ind & Ir–July 19. 600 w.

499. The Mesaba Range (Commercial character of ores ; sampling ; mining costs). Ir Age–Aug. 1. Serial. 1st part. 3800 w.

510. Production of Iron Ore in the United

States in 1894 (Advance statistics of the United States Geological Survey). Bul Ir & St Asso–Aug. 1. 1500 w.

524. Metalliferous Deposits in Fissures. Melville Atwood (Theory of vein formation). Min & Sci Pr–July 27. 2800 w.

529. The Possible Revival of Virginia City, Nevada. L. P. G. (Geological outlook.) Ill. Sci Am Sup–Aug 3. 1400 w.

*550. The Proximate Analysis of Coal. S. W. Parr (Apparatus and method for simple tests). Am Eng & R R Jour–Aug. 1000 w.

*561. Ellangowan Colliery. Ill. George B. Hadesty (Seams worked; system; surface plant). Col Eng–Aug. 3800 w.

*562. The Luke Fidler Mine Fire. Ill. Baird Halberstadt (Slushing with culm and water; tunnel and shaft dams). Col Eng–Aug. 2800 w.

*564. Modes of Working Coal. J. B. Hanford (Paper read at Meeting of Mining Inst. of W. Cent. Penna). Col Eng–Aug. 500 w.

*565. A Lecture on Mining. W. N. Atkinson (Accidents; training of mining engineers). Col Eng–Aug. 2000 w.

*566. A Novel Steel Tipple. Ill. (Convenient arrangement; Forest Hill Mine, Penna). Col Eng–Aug. 600 w.

579. Transvaal Gold Mines in 1895 (Statistics; increased production). Eng & Min Jour–Aug. 3. 1000 w.

580. The Fourmile Placer Fields of Colorado and Wyoming. Ill. E. P. Snow (Geological; technical). Eng & Min Jour–Aug. 3. 2000 w.

581. An Experiment in Coöperative Mining. D. W. Brunton (Lease System at Aspen). Eng & Min Jour–Aug. 3. 1200 w.

†583. The Geological Survey of New South Wales (Abstract of colonial report). Ind Engng–July 6. 1300 w.

†585. Gold Mines in Victoria. H. (Abstract of colonial report). Ind Engng–July 6. 1000 w.

587. Electricity in Coal Mining. Ill. (Plant at Mount Lookout Colliery). Tradesman–Aug. 1. 1800 w.

603. I. The Outlook for Canadian Phosphates. Editorial. II. Phosphate's Future. Robert C. Adams. III. Phosphoric Acid in Agriculture. Frank T. Schutt (Problem of marketing low grade rock). Can Min Rev–July. 10500 w.

604. The Use of Electrical Apparatus in Mining. W. F. Dean (Power transmission; hoists; pumps; haulage; drills). Can Min Rev–July. 3000 w.

605. Canadian Phosphate and Fertilizers. J. Burley Smith (Home manufacture and home market). Can Min Rev–July. 5000 w.

610. Gold Mining in Georgia. F. W. H. (Reprint from Southern Cultivator; early history). Min Rev–Aug 2. 1300 w.

*612. Mining in Spain. From report of C. S. Smith (Iron and coal). Ir & Coal Tr Rev–July 26. 1400 w.

*613. Some Observations on the Western Part of the South Wales Coalfield. Thomas Arnold (Abstract of paper presented to the South Wales Inst. of Min. Eng. Geological). Ir & Coal Tr Rev–July 26. 2500 w.

*633. Firedamp and Coaldust in Austrian Mines. From report of R. Lamprecht. (Means adopted for the prevention of explosions in Austro-Hungarian mines). Col Guard–July 26. 800 w.

636. Alabama Gold Discoveries. H. S. Fleming (Investigation by expert). Mfrs Rec–Aug 2. 400 w.

*640. Victorian Gold Mining. Thomas Cornish (A description of the Dunolly gold field, one of the most important in Australia). Min Jour–July 27. 1500 w.

†656. System of "Long Wall" Used in Northern Illinois Coal Mines. Ill. G. S. Rice (Description and discussion). Sch of Mines Quar—July. 3000 w.

Miscellany.

*245. The Exports of Iron and Steel from the United States. Editorial (Increase; competition). Ir & Coal Tr Rev–July 5. 1000 w.

*254. Occurrence and Mode of Working Petroleum in Lower Alsace. L. Van Werveke (Abstract of paper read before Fed. Inst. of Min. Eng. Geological and technical). Col Guard–July 5. 2700 w.

347. Fluming Ore in Alaska. N. S. Trowbridge (Economy of transport; mine and mill). Min & Sci Pr–July 13. 700 w.

362. Pig Iron Production and Business. (Editorial. Statistics; prices). Age of St–July 20. 1000 w.

443. The Montana Mining Law. (With comments by R. W. Raymond). Eng & Min Jour–July 27. 4800 w.

453. Platinum in Alaska (Reported discovery). Bos Jour Com–July 27. 400 w.

*470. The Economic Importance of the Murchison Range. The Gold in the Conglomerate (Geologic). Min Jour–July 20. 4400 w.

*487. Coal and Iron in Spain (Statistical). Col Guard–July 19. 1800 w.

*563. The Proposed Amendment to the British Mining Law (New sections criticised). Col Eng–Aug. 2500 w.

*635. The Coalfields of the United States (Descriptive and statistical). Col Guard–July 26. 1600 w.

*638. The Superficial Alteration of Ore Deposits. R. A. F. Penrose, Jr. (Treats of both mechanical and chemical courses of superficial alteration which extend to a depth of hundreds of feet). Aus Min Stand–June 22. 2600 w.

*641. Slate Quarrying. Editorial (Business opportunities in New South Wales). Min Jour–July 27. 1300 w.

†653. Segregation in Ores and Mattes. David H. Browne (Theory of origin of Sudbury nickel-ore deposits, with appended note by J. F. Kemp). Sch of Mines Quar–July. 3000 w.

MUNICIPAL ENGINEERING

Water-Supply for Tall Buildings.

THE department of public works of the city of New York has very properly declined to supply to the tall buildings now erected and in process of erection water under pressure sufficient to carry it to the upper stories. If the upper stories are to be supplied, the owners of such buildings will be required to pump it up there for themselves. The city will supply the water, but not the pressure. In explanation of this position, Gen. Collis, deputy commissioner of public works, made in the New York *Sun* of July 15 a statement, of which the following is an abstract:

"The problem which confronts us is one of distribution, not of supply; and even this, though serious, is in no way alarming. The present average daily consumption is a little less than 200,000,000 gallons; yet the supply on hand in the several storage and other reservoirs is 18,000,000,000 of gallons. In other words, we have 90 days' supply on hand.

"The increase in daily consumption during the past 5 years has been 25,000,000, so that in 1900 we will be using 250,000,000 a day, by which time the dams at Carmel and Amawalk will be completed, giving us a volume of 17,000,000,000 additional gallons, making a total of 35,000,000,000. Five years later at the furthest, the great dam at Cornell will be finished, increasing the supply by 25,000,000,000, making a grand total of 60,000,000,000 gallons of pure water, well protected against contamination, to furnish a demand of, at the utmost, 400,000,000 a day. And back of all this are the waters of Lakes George and Champlain, and the vast acres of Adirondack lakes. Perhaps this is going far enough into the future, and yet Lake Erie is left to us,—one of those great fresh-water seas which God created for some wiser purpose than navigation. After that the deluge."

Gen. Collis admits, however, that the system of distribution is unsatisfactory, but claims that it is receiving the attention it deserves. As to the pressure clamored for, by some,—a pressure that would force water to the fifteenth or twentieth story,—he thinks that owners of lower buildings who put in their plumbing before tall buildings were erected have some rights which are entitled to consideration.

"The pressure necessary to force water to the top of the tall buildings now being erected would play havoc with the plumbing of the buildings down town which were erected a quarter of a century ago, for water will refuse to climb until it has exhausted every other effort to escape.

"Surely the people who are thus in jeopardy are entitled to some consideration. The plumbing referred to was gaged, when new, to resist a pressure of 40 lbs. to the square inch. The present down-town pressure is 15 lbs. in day-time and 25 lbs. at night. Increase it 10 or 15 lbs., which might carry it to an elevation of 75 ft. at Wall street, and something would have to give way. If an announcement was made to-day that the pressure would be increased to 40, or even 35 lbs., on the 1st of January next, all the plumbers in New York could not get the hotels, office-buildings, apartment-houses, and tenement-houses, and the homes of small consumers in condition to meet the change. It would be a great season for plumbers, but how the landlords would howl!"

"Those who have erected buildings on the outskirts of the city, where, as yet, no water mains have been laid, and then, in the *rôle* of ill-used taxpayers, demand that water-mains shall be laid immediately to meet a want which they have anticipated perhaps by several years . . . . have only themselves to blame. They are at liberty to procure water from the nearest source," but Gen. Collis warns the public that the time is approaching when restrictions will be enforced as to the time in the day that pumping can be allowed, in order to prevent interference with supply in denser portions of the city. It is asserted that 25 per cent. of the water-distribution of the city goes to waste, which seems to us an underestimate. It is also asserted that the law requiring meters to be located in every building except those used exclusively for dwellings is evaded.

A valuable suggestion relating to fire-protection for tall buildings is of general application. "The problem of fire protection for the vertical growth of the city in high buildings which are looming up at different points and frequently in isolated localities is a separate question. They must not expect to be provided for, so far as pressure is concerned. A separate circulation for high pressure for their special protection would be so costly as to be prohibitive; therefore the reasonable way to dispose of this matter belongs to the owners themselves, and to the water-lifting and throwing apparatus of the fire department,—*viz.*, portable water towers and steam fire engines. So long as the city pipes are sufficient to supply these engines with reasonable pressure—say 20 to 30 lbs. to the square inch—protection for these high buildings is provided for, and the city does its part. The owners of such buildings might now speedily protect themselves by having pipes placed on the outside of their buildings, to which the fire-engine hose could be attached. These would answer the purpose of a high portable tower for each building and its neighborhood, the pipes remaining empty save in the case of fire. Provided with this simple fire stand pipe on each high building, the pumping power located within, or in a neighboring building if the burning building was not available, could be so connected as to supplement the fire department apparatus. Thus the city's responsibility would lie in furnishing the requisite quantity of water, instead of the excess of pressure, and in so equalizing the distribution that at any and all times sudden demands would be met."

A danger which, it is to be hoped, is remote, but which might be at some time calamitous, is incurred by all "salt-water cities,"—New York especially.

"Here are two million of souls absolutely dependent upon a base of supply nearly 40 miles distant from the field of consumption, the line of communication being an aqueduct, sufficiently well guarded perhaps in time of peace, but, in case of war or insurrection, more tempting to an enemy than a poorly-defended harbor. Lake cities and those built upon the banks of inland rivers are in no such jeopardy, but the protection of the water-supply of all sea-coast cities is, in my opinion, as grave a question for the consideration of the national government as the construction of harbor defenses or navies."

Scientific Filtration.

THE purification of sewage has progressed so rapidly of late and on such distinctly scientific lines as to justify the above title of an editorial in *The Engineer* (July 12). This editorial deals with a report recently made by Mr. Dibdin, chemist of the London county council, upon elaborate and carefully-conducted experiments instituted for the purpose of ascertaining the best methods of filtering the sewage effluent at the northern outfall precipitation works. Two series of experiments were carried out. The significance and importance of the results will be apparent from the following quotation.

"In the first series of experiments the filters were built of wood, and were four in number, each equal in area to the two-hundredth part of an acre. The operations commenced as far back as June, 1892, and by the month of August in that year it was found that the degree of purification effected by coke breeze exceeded that obtained with any other material, the comparison being made with burnt ballast, sand, pea ballast, and a proprietary article combined with sand. The reduction in the amount of oxidizable organic matter in solution was 62.2 per cent. in the case of the coke breeze, the nearest approach to this result being that afforded by the use of the proprietary article in combination with sand, the reduction in that case being 61.6 per cent. Burnt ballast went no further than 43.3 per cent., and was the lowest on the list. The proprietary filter is said to have excelled the coke breeze so far as concerned the degree of improvement effected in the appearance of the filtrate, but, while the actual purification fell a little short, the cost was such as to be prohibitory. The conditions of success among the various filters were found to consist in porosity, and the consequent power of re-absorbing atmospheric oxygen. For foul waters sand proved too fine, and burnt ballast too coarse. Numerous gelatine plate cultivations were made, and it was discovered that the greater or less number of micro organisms present afforded no indication of the degree of purification effected. As a rule, the microbes were more numerous in the filtrates than in the tank effluent before filtration. Whether the microbes were few or many, the object aimed at was the attainment of the highest degree of speed consistent with such purification as would remove all objection in respect to odor and liability to putrefaction.

"So much being learned, a second series of experiments was entered upon, in which each filter covered exactly 1 acre of land. The first result was to clog the coke breeze filter with sludge, and to render it putrid throughout in less than 3 months. It was thus shown that rest and aeration were vital. A more cautious and gradual mode of proceeding, in which the filter was merely filled and emptied twice daily, secured the necessary biological conditions, and produced satisfactory results. About 500,000 gallons of effluent passed through the filter daily, and the purification ranged between 70 and 80 per cent. After a full month's working the purification reached 83 per cent., and fish placed in the filtrate were kept alive for many weeks. The daily quantity of effluent was afterwards increased to over 600,000 gallons, the analytical results being still highly satisfactory. At last the filter was made to pass an average of 1,000,000 gallons per day, including all times of rest, and for 8 weeks the filtrates were clean and sweet, the purification effected being 78 per cent. 'Nitrification proceeded satisfactorily,' says the report, 'and the filter was apparently capable of continuing for an indefinite time.' Great importance naturally attaches to the fact that the filter worked efficiently during the extraordinary frost which occurred in the early part of the present year. The experiments, taken as a whole, are considered to show that sewage, especially if previously clarified by precipitation, 'may be purified to any desired degree.' The actual amount of purification depends on the length of time during which the effluent is allowed to remain in contact with the filter, and the length of time allowed for aeration. If a reduction of 75 per cent. in the oxidizable organic matters in solution is considered sufficient, the quantity that can be treated daily on 1 acre of coke breeze is 1,000,000 gallons."

Glasgow Hydraulic Power Supply.

NOTWITHSTANDING the intense opposition which increase of municipal control of the supply of public necessities has met, it appears that a gradual extension of such control is in progress. One of the latest examples is the supply of hydraulic power in Glasgow for the elevators and presses of that city, which is interesting from both engineering and economic points of view. In this enterprise Glasgow has followed the lead of Hull and London. *The Engineer* (July 19), in a general description of the Glasgow plant, says that "works were laid down in Hull in 1874, and in 1882, 1883, and 1884 works were established in London, where they have proved to be of great public utility. In London there are 75 miles of mains, with a pressure of 750 lbs. on the square inch. The number of machines working from these mains is twenty-three hundred, bringing in a revenue of £50,000. In these circumstances it was not to be expected that the 'second city' of the empire would long remain without the immense facilities which hydraulic power —for special purposes undoubtedly supreme—confers upon large commercial and industrial communities.

"Originally a private company intimated its intention of supplying the needs of the city of Glasgow, represented mainly by some six hundred hoists and hydraulic presses scattered over the city's area, but they relinquished the project when the water commissioners of the corporation made it known that they themselves had resolved to enter upon the undertaking. This ended the matter so far as private enterprise was concerned, as it was clearly realized that none but a very strong commercial company could have carried out the scheme to a satisfactory issue. Independently of the main items of cost—the site, the buildings, the machinery pipes, and work—there was the question of way-leave for pipes through the streets. The city's authorities have always strictly conserved their rights and privileges in this connection, and would not lightly have given any company permission to open up the 10 miles of thoroughfare through which the pipes extended."

In the design of this plant provision has been made for a large increase in the use of water pressure over present needs, and the present instalment is only sufficient for half the full capacity. The water is furnished at a pressure of 1120 lbs. per square inch, to supply which, in the present stage of development, four large Lancashire boilers with economizers, and three sets of pumping-engines, are used, each of the latter pumping 230 gals. of water per minute against the accumulator pressure named. Steam pressure of 120 lbs. is supplied to the engines. The water is pumped into a huge iron tank,—capacity, 200,000 gals. The latter is made of ¾-in. and ⅝-in. plates of the best quality, which were subjected to the severest tests before use.

"The accumulators, two in number, have rams 18 in. in diameter, with a 23-ft. stroke. The cylinders are cast in one length, and the rams are also each of one piece of cast metal turned. The engines work independently, each one delivering into one of the four 7-in. main pipes. While the pressure on these is supplied from the accumulators, they have been so arranged that, should necessity arise, the pressure on the delivery mains can be supplied from one accumulator. The four main pipes have been laid throughout the district of supply in such a way that they form two separate circuits,—one circuit to the north of Argyle street—the grand artery running east and west in Glasgow—and the other to the south. At certain points there are cross connecting pipes with valves, which will enable the system to be worked as one or two separate circuits. There is a further provision against stoppage of the whole hydraulic supply through fault at any particular place. Connected with the 7-in. delivery mains, there are in the chief streets 6-in. and 5-in. pipes. All of these are provided with valves, enabling any street to be cut off from the general circuit, should this be necessary."

Huge Water Supply for London.

THE *Sanitary Record* (Aug. 2), gives a general popular description of the new scheme of water supply for London. There is now felt the imperative necessity for an increased supply, and it is asserted that the water at present supplied is too impure to be fit for domestic consumption. Altogether, the people of London are sadly incommoded both by insufficient supply and the character of the water they are compelled to use.

The recent Royal Commission on the water supply came to the conclusion that the supply of water required for the metropolis was likely to increase from 171,000,000 gallons to 415,250,000 gallons daily in 1931, thus more than doubling the quantity at present provided. During the course of that investigation the water companies submitted that an additional supply of 300,000,000 gallons could be obtained from the river Thames, this supposition being based upon the assumption that the latter could be treated in a manner similar to the Lea—that is, that nearly all the water could, without harm be abstracted from it. Further investigations which have been carried out since the date of the Royal Commission have, however, proved that this quantity, having regard to the general welfare of the metropolis, cannot with safety be taken from the river. They have also demonstrated that the purity anticipated by the Royal Commission can hardly be expected to continue in the future with the present increasing population of over 1,000,000 persons in the Thames Valley, as the investigations have shown that the existing filter beds are unable to cope with the discolored flood water which comes down the Thames, and which is always charged with large amounts of bacterial life.

The urgency of the matter is illustrated by the fact that the gathering grounds are gradually being appropriated by other towns, as for instance Manchester at Thirlmere, Liverpool at Lake Vyrnwy, Birmingham in Wales, and other towns elsewhere. But where is London to seek for an ample supply? The engineer to the County Council, Mr. A. R. Binnie, has been making inquiries outside the metropolis as to supplementary sources of supply, and the result is the preparation of the most gigantic water supply scheme yet elaborated.

This enormous scheme, the carrying out of which would involve a capital expenditure of £38,000,000, is based upon the utilization and conveyance to the metropolis of water from South Wales. There are five main sources of supply—the valley of the Usk, Yrfon, the Edw, the river Ithon, and the upper portions of the Wye proper. The geological formation of the ground and the contour of the valleys lend themselves admirably for the easy erection of large reservoirs, and the supply is estimated at 415,000,000 gallons a day.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Gas Supply.

72. The Enriching Value of Benzole and Acetylene. F. L. Slocum (Shows causes of variation in tests of benzole, and makes a general comparison of its enriching value with that of acetylene). Am Mfr & Ir Wld–July 5. 1600 w.

159. Some Improvements in the Methods of Manufacturing Sulphate of Ammonia. C. Stafford Ellery (Extracts). Pro Age–July 15. 600 w.

168. Acetylene as an Enricher. E. G. Love (Supplementary to a paper read by the author before the Society of Gas Lighting. Comprises a diagram and tables of candle power of various gaseous mixtures. The most hopeful outlook for acetylene is its use *per se* in small gas burners). Am Gas Lgt Jour–July 15. 800 w.

169. The Production of Cyanides. From paper of M. G. Perthius (Products rich enough in cyanides to be profitable produced in gas manufacture. Chemical reactions and process described). Am Gas Lgt Jour–July 15. 1000 w.

*219. Thwaite's Power-Gas Plant. Ill. (Describes a plant for manufacturing motor gas by the Thwaite continuous cycle process, or non-reversal process, in which the hydrocarbons are actually burnt in one vessel and recarbonized in a second vessel, and by which the difficulties in using bituminous coal are removed). Eng, Lond–July 5. 2300 w.

*313. Incandescent Gas Lighting. S. M. Highlands (Competition of electric lighting and the Welsbach system). Gas Wld–July 13. 1700 w.

456. Notes on Cyanogen in the Manufacture of Illuminating Gas. M. G. Perthius (In view of the increased attention now directed to the production of cyanides in gas manufacture, this is a very important paper. The subject is thoroughly treated. Translated from the French by Hermann Poole). Am Gas Lgt Jour–July 29. 4000 w.

*497. Chemico-Technical Investigations at the Technical College of Carlsruhe. H. Bunte (Abstract translation of preliminary report on work now in progress at Carlsruhe Technical College on products of combustion of gas flames, tests of incandescent burners and carburetting). Jour Gas Lgt–July 23. 2800 w.

528. The New York and East River Gas Company's New Holder. Ill. (Descriptive). Pro Age–Aug. 1. 1400 w.

596. Welsh Anthracite Coal. John L. Howard (States most recent and accepted theories of the formation of bituminous coal, composition of many varieties, and qualities essential for production of illuminating gas). Am Gas Lgt Jour–Aug. 5. 7000 w.

597. Technical Gas Analysis. J. Bryant Grimwood (Modern rapid methods). Am Gas Lgt Jour–Aug. 5. 3700 w.

598. The Economy of Small Works. John Clements (Practical management; discussion). Am Gas Lgt Jour–Aug. 5. 3000 w.

*630. The Glasgow Gas Works. Ill. (Descriptive). Engng, Lond–July 26. Serial. 1st part. 2400 w.

*667. Notes on the Chemical Constitution of Illuminating Gas in Relation to Its Illuminating Value, and on Some of the Physico-Chemical Conditions which Influence the Luminosity of Gas-Flames. W. Young, with Discussion. Jour Gas Lgt–July 30. 13500 w.

Sewerage.

†17. The Sewerage of Bradford, England. Claude Meeker (Report from an official source of a system wherein sewage and rainfall flow into the same sewer). San–July. 1500 w.

238. Ventilation of Separate Systems of Sew-

erage. Parker N. Black (Considers the presence and character of gases in sewerage systems, advocates ventilation of sewers, but independently of house drains). Eng Rec-July 13. Serial. 1st part. 1300 w.

*359. Scientific Filtration (Editorial. Discusses the experiments made by the Main Drainage Committee of the London County Council). Eng, Lond-July 12. 1200 w.

*397. The Chemical Constitution of Gas Enrichers, and Its Relations to Their Enriching Value. Wilfrid Irwin (A paper read before the Manchester section of the Society of Chemical Industry, with discussion. A very thorough examination of the subject with illustrations of gas flames as affected by enrichment). Jour Gas Lgt-July 16. 5800 w.

*606. York Sewerage Works (Brief description). Ind & Ir-July 26. 600 w.

Streets and Pavements.

409. The Wear of Brick Paving at Johnstown, Pa. (Table of Records). Eng News-July 18. 600 w.

*418. Street Subways for Large Towns. Charles Mason (Abstract of paper read at a recent meeting of the Soc. of Eng). Gas Eng Mag-July 10. 2000 w.

*542. Natural Rock Asphalt Paving in Europe Ill. W. H. Delano (General description of the system and the method and plant for manufacturing the blocks). Paving-Aug. 1200 w.

*543. Brick Paving Specifications in Leading Cities (Abstracts of specifications of various leading cities where best work has been done). Paving-Aug. 2300 w.

589. How to Make a Good Paving Brick. J. W. Penfield (Criticism of article by T. Townsley. Brick-Aug. 2000 w.

Water Supply.

46. New York City's Water Supply (Editorial deploring low pressure). Fire & Water-July 6. 500 w.

47. Some of the Difficulties and Advantages that Have Arisen by the Use of Meters in a Southern City. Fred Crosby (Paper read at Atlanta Convention of Am. Water Wks. Asso. Ambiguous city ordinances. Contests wlth consumers). Fire & Water-July 6. Serial. 1st part. 2600 w.

48. Electrolysis Threatens Brooklyn's Water Mains. George W. Plympton and Fred R. Lee (Effective protection by conductors). Fire & Water-July 6. 600 w.

226. New York's Water Supply. Ill. (Review of James C. Duane's report to the Aqueduct Commission. Work done on the Croton Aqueduct, 1887 to 1895). Fire & Water-July 13. 1000 w.

237. The Water-Works of Asiatic Constantinople. Ill. (Reservoir; dam; filters). Eng Rec-July 13. 1100 w.

340. The Jerome Park Reservoir. Ill. (Construction; capacity). R R Gaz-July 19. 1000 w.

455. The New Water Supply for Waterbury, Conn. (Abstract of lecture by R. A. Cairns, before students of Rensselaer Polytechnic Inst). Eng Rec-July 27. 5000 w.

*477. Glasgow Hydraulic Power Supply (Account of the municipal supply of water for hydraulic elevators in Glasgow, Scotland. Water supplied at 1120 lbs. pressure per sq. in). Eng, Lond-July 19 2000 w.

*632. Craigmaddie Reservoir for Glasgow Water Supply. Ill. (Record of details. Problems of novel character). Engng, Lond-July 26. 3600 w.

651. An Enclosed and Wind-Braced Standpipe, St. Charles, Mo. Ill. Edward Flad (Descriptive). Eng News-Aug. 8. 1800 w.

663.—$1.50. The Water-Works of Syracuse, N. Y. William R. Hill, with Discussion. Ill. (Description of works and their erection). Tr Am Soc Civ Eng-July. 13000 w.

*670. Huge Water Supply Scheme for London (Outline description). San Rec-Aug. 2. 900 w.

Miscellany.

*7. Surveying and Mapping a City. C. H. Rice. (The great importance of accurate work). Eng Mag-Sept. 2800 w.

*178. Calorific Value of Refuse (Account of Mr. Naylor's experiments and their results, with tables,—and use of refuse in steam generation). Elec Eng, Lond-July 5. 3000 w.

*241. The Growth of Sanitary Engineering During the Past Twenty-one Years. H. Percy Boulnois (From an English standpoint). San Rec-July 5. 3200 w.

*243. The Efficiency of the Refuse Destruction (Abstract of Paper read before Asso. Mun. & Co. Eng. at Halifax. Record of Royton Experiments; refuse burning). Ir & Coal Tr Rev-July 5. 1000 w.

*569. The Clearing of Mulberry Bend (The story of the rise and fall of a typical New York slum). Ill. Jacob A. Riis. Rev of Rev-Aug. 4500 w.

572. Philadelphia's Fire Bureau. Ill. (Abstract of report of R. A. M. Beilter, Head of Dept. of Public Safety, describing recent improvements in the city's fire bureau). Fire & Water-Aug 3. 600 w.

*576. Cleveland Conference for Good City Government. Clinton Rogers Woodruff (The conference a distinct success). Am Mag of Civ-Aug. 1800 w.

*578. The Health of London (Statistics and comments from Report of the London County Council's Medical Officer). Nature-July 25. 1800 w.

*666. Gas Flames and Luminosity (Editorial review of a paper read by Mr. Wilfrid Irwin before the Manchester Section of the Chemical Society). Jour Gas Lgt-July 30. 2300 w.

†684. The Proper Diameter of Fire-Hose. Ill. B. L. Stowe (Regarding the effect of different sizes upon the wearing qualities). Ind Rub Wld-Aug. 10. 1100 w.

RAILROADING

Track for Heavy Locomotives.

In the *Engineering News* for July 25 there appears an article without signature on "Track for Heavy Locomotives," containing many interesting data. After commenting upon the comparative lightness of the track of many American railways which use very heavy locomotives, it states that the conditions of safety and maintenance vary according to the nature of the road and traffic, as a light track which would be safe on straight and level line, where the trains run easily, might be dangerous and expensive on a line with sharp curves and steep grades, over which the engines work very heavily. On the other hand, a well-laid and maintained track may give better service than a relatively heavier track with low joints, worn ties, and loose ballast. Referring to an article that appeared in the issue for May 9, in which the dimensions of several of the enormously heavy engines were given, it now gives, in connection with these, data in regard to the tracks over which these engines are running. They are as follows:

Railway.	Type.	Total wt. in lbs.	Wt. per Driver lbs.	Rail lbs. per yd.	Max. grade %
Southern Pac.	12 wheel	173,500	18,333	76	2.2%
Dul. & Iron R'ge.	"	169,000	17,375	60 80	
Great Northern	"	156 000	17,000	80	
Bur. & M. River	Decapod	150,300	15,030	56,66,75	3%
C'nwall & Leb.	Consol.	150,000	16,875	60	1.7%
Del. Sus. & S.	Mogul	151,500	22,650	60	

Mr. R. Augst, chief engineer of the Duluth & Iron Range Railroad, is quoted as stating that the twelve-wheel engines were too heavy for the original track, which consisted of 60-lb. rails spliced by 24-in. angle bars and four bolts, and having 110 linear in. of tie face per 30 ft. rail. In 1888 renewals were begun giving 125 in. per rail-bearing tie surface. Trials are now being made with ties 7 in. thick. The above is for 60-lb. rails on new work, but on the old track 80-lb. rails are used spliced with 23-in. Sampson angle bars and home-made base plates at the joints. The ballast is gravel of various degrees of coarseness. While there are twice as many consolidation engines with 103,000 lbs. on a driving-wheel base of 14 ft. 1 in. as there are twelve-wheel engines with 138,000 lbs. on a driving-wheel base of 15 ft. 6 in., there is a decided increase in wear and tear and in the number of low spots in the track, as well as much shortening of life in the bridges built before 1892 or since renewed, but the proportion of this increase due to the twelve-wheel engines cannot be estimated with any degree of certainty.

This road is rapidly reinforcing its bridges, and is increasing the tie-bearing of the rails as fast as the track is renewed. Mr. Augst states that he is satisfied that in a short time the cost of maintenance with 80-lb. rails and twelve-wheel engines will not exceed that for the 60-lb. rails and consolidation engines, and he is not prepared to advocate a heavier rail for any purposes of economy.

The preparation for an increased weight on driving wheels has led to a reduction in cost of maintenance with the lighter engines, and has enabled still heavier engines to be used with very little extra expense for reinforcing track and bridges. The effect of the heavier driving-wheel loads of the twelve-wheel engines is apparently in a vertical direction, disturbing the surface of the track, as there is no noticeable increase in the nosing motion of the engines and incidental widening of the gage.

Mr. John F. Stevens, chief engineer of the Great Northern Railway, says that the track upon which the heaviest engines run consists of 80-lb. rails, spliced with 36 in. angle-bars, weighing 30¼ lbs. each, and six bolts. There are sixteen ties to a rail length, and the ballast is mainly coarse gravel. He says there is no special extra cost for maintenance where these heavy engines are used.

Mr. Weeks, in speaking of the tracks of

the Burlington & Missouri River Railroad, says that the rails of 56, 66, and 75 lbs. have eighteen ties to the rail length, with cinder or gravel ballast. The joints are spliced with four-bolt angle bars on the lighter rails and six-bolt bars on the 75-lb. rails,—the bars extending over three ties. The decapod engine running over the 56-lb. rail caused no more apparent wear than a consolidation engine, and he believes that, when run at low speed (12 to 15 miles per hour), they can be run on less substantial track than is required for class H mogul engines at 45 to 60 miles per hour. No extra maintenance of track is required where these decapod engines are used.

Mr. John McDonell of the Cornwall & Lebanon Railroad states that the consolidation engines weighing 150,000 lbs. in use on that road work very easily, and the 60-lb. rail is considered perfectly safe. He thinks, however, that a 60-lb. rail with sixteen ties to the rail is too light to be economical with engines with wheel loads as large as 16,875, and this opinion is confirmed by the experience of the Duluth & Iron Range Railroad.

The Delaware, Susquehanna & Schuylkill Railroad has ten mogul engines weighing 151,500 lbs. with 135,900 lbs. on a driving-wheel base of 14 ft. The track consists of 60-lb. rails carried by fifteen ties to the rail length. Ballast, cinder. Mr. Kudlich reports that with one and a half men per mile the track can be repaired and kept in perfect condition.

Compound Locomotives.

A RUNNING discussion upon this subject at one of the noon sessions of the recent master mechanics' convention (*Railway Age*, July 5) indicates the estimation in which the compound locomotive system is now held in the United States. Much practical experience with compound locomotives was recounted, and the general consensus of opinion was decidedly favorable to the system.

Mr. Garstang reported a saving of 22.9 per cent. in fuel by the use of a compound locomotive as compared with that of 59-in. simple, ten-wheel locomotives used on the same road, and stated that the cost of maintenance of the compound locomotive was less than that of the simple. Mr. Gibles said that he was "convinced that the compound is the coming locomotive for freight service, and that it behooves us to help this advancement all we can. We will make some mistakes in the compound; you may say it is an easy matter to stick on another cylinder, and therefore it should not be much of an experiment. It is a radical change, however; it changes the steam distribution, valve motion, etc. The compound engine offers the most universal means of accomplishing a fuel economy of 15 per cent. We have had one compound for 4 or 5 years; we ascertained the economy on an elaborate test of the engine, and it is still showing that economy. I find from a record of 2 years' performance there has been spent an average of about 2½ cents a hundred miles for repairs as against 4.7 cents for the other engines of the same class,—about $1000 a year less. It is easy to make 10 per cent. difference in the coal economy, saving $500 a year in fuel."

Mr. Barnes warned against the use of too many automatic devices, and advocated independent exhaust. He alleged that extravagant reports of the economy of compound engines had been promulgated. "In a paper read before the American Society of Mechanical Engineers 18½ lbs. of steam per horse-power hour, was claimed. Another man claimed 17½, but he did not give all the facts. He measured his 17½ lbs. from the indicator card, while the engine itself showed probably 24,—quite another matter. Some discoveries relative to indicator cards, resulting from tests on compound engines, have been made. We find that with a long pipe you can make an engine show 1000 h. p. when she has only 800 h. p. The compound locomotive started out in this country with one low-pressure piston, weighing 800 lbs. The builders have been forced to go to a light piston. If there is any difficulty in the way of the further introduction of the compound locomotive, it is in the matter of the reciprocating parts. Railroad superintendents are becoming exercised by the damage to track not accounted for by the passing of loaded cars over the track. It comes from locomotives, and because of excess balance; and for high speeds, where the wheels are not very large, it may be we will have to stick to simple engines for that reason alone. In England the compound has been abandoned, while in Germany and other countries, where the railroads are under the control of the government, and haul their trains more ecenomically, the compound is on the increase. One of the causes of reported failures of compounds is to be found in the fact that they are not always adapted for the work they are called upon to do."

Mr. Vauclain said: "The building of compound locomotives is not attended with good luck at all times. You have a certain amount of grief mixed in with the joy that comes to you, and you have got to put up with it. It is the grief which prompts you to do the work. The use of compound locomotives has given to railroad companies in the United States a means of reducing their operating expenses to a greater extent than any other item of improvement connected with the operation of locomotives. We have had several examples lately of how energetically the companies proceed in the methods of saving oil. If the railroad companies would proceed as energetically in the direction of perfecting the compound in saving fuel, the amount saved would have a greater bearing upon the cost of operating their locomotives. If we turn to Europe, where they have been using compound locomotives for a much longer period than we have, we will find that, on the whole, compounds are making great headway."

In the course of further remarks the speaker added that "for high-speed service the single expansion engine is needed to a certain point. After that point is reached, you must get back to compound cylinders in order to increase the efficiency of your boiler, and get advantage of the 15 or 20 per cent. you are able to save in the consumption of water. When you operate a compound locomotive up to its maximum efficiency, evaporating 65 gallons of water a minute, if single expansions were applied to the same engine, it would be impossible to make the speed."

Mr. Mitchell gave his experience with light Baldwin compounds. "They have been in service for 2 years, on fast and slow trains,—mostly fast freight trains,—and giving excellent results. They save from 8 to 10 per cent. in coal and about 15 per cent. in water. The water is more important, as the incrustation of the water with us is very great; with the simple type we only get 8 or 10 months' service out of the flues; with the compound, 12 to 14 months'."

Mr. Herr thought that a considerable saving of coal could be effected by the use of the compound locomotive, "especially in freight service." Mr. Davis thought that the compound locomotive was the locomotive of the future, but that the progress would be more rapid if the advocates of the compound were more moderate in their claims.

Manual Interlocking.

THE early stages in the evolution of methods of train-handling are traced by Mr. George H. Paine in an entertaining paper on "Certain Interesting Features in the Manual Interlocking of Railroads (*Proceedings of the Engineers' Club of Philadelphia*). The first step he considers to have been brought about by an effort to reduce the cost of handling trains, and consisted simply in stationing men permanently at certain switches, so that they might be opened without having to stop trains. "From this one fact all interlocking probably took its rise, for it was soon discovered that one man could take care of a great many switches, if he could only get to them; so somebody proposed taking the switches to the man, which was done forthwith." In the meantime "somebody else suggested that, if an engineman could, through a signal, know something about how he was going to find a switch a little before he reached it, time and money would be saved, since he would not then be always required to come nearly to a stop in approaching switches in obscure locations or else run the chance of a disaster. It was evident at this point that the man who controlled the switches must also control the signals. In this way the operating mechanism of both signals and switches came to be placed side by side." The idea of interlocking is credited by Mr. Paine to English railroad men, and "it must also be recorded, to our shame, that the use of interlocking had reached a highly-developed state in England before even a start had been made in this country."

The aims of interlocking are, first, to decrease dangers; second, to facilitate and therefore reduce the cost of handling trains. Mr. Paine here remarks that fortunately the two usually go hand in hand, for in the management of trains that plan which will result in an ultimate economy is likely to prove the safest.

While the theory of interlocking is perfectly simple, the practice is most complicated, especially where there are a large number of levers in a machine. Not only may a certain arrangement of tracks be interlocked in several different ways, but, a certain scheme having been decided on, the several combinations which result may be secured by a widely different arrangement of locks. The locking is performed by the shifting of "dogs," the series of dogs connected with one lever being moved in such a way as to either prevent or permit the movement of all the other levers concerned in that combination. The dogs are mounted on locking bars, which in turn are fastened, through the medium of a small shaft and a link, to the latch of the lever. By this arrangement all of the necessary levers are locked fast before any movement takes place in the lever to be thrown; and none of those levers which have been locked, but are to be unlocked, are released until the lever in action has reached its new position and is latched there. Furthermore, no change in the locking takes place during the movement of the lever itself. The technical expression given by Mr. Paine for this essential feature of all good locking is "preliminary."

Next to the machine itself, the most interesting features of the system are the signals, the selectors, the facing-point locks, the detector bars, and the compensators,—the object of which arrangements is to make it absolutely certain that the proper signal will be cleared, that every switch over which a train must pass will be set and locked in the correct position, and that every signal which controls a conflicting movement will be locked in the danger position. Many of the mechanical devices employed for the purpose are shown in the diagrams accompanying Mr. Paine's able essay.

Color of Semaphores.

In the discussion which followed the reading of Mr. Paine's paper, it was stated that in England yellow semaphore arms are quite frequently used, because that color can be seen better. The author did not consider it better than red, if the proper shade of red is used and the blade kept properly cleaned and frequently painted; and he said that the advantage of the yellow is that it has no significance in signals at all. Dr. H. Leffmann remarked that yellow has been considered by some authorities as the most brilliant color to the human eye, but added that whether it would be suitable for semaphores would depend on the landscape. Standing out against the blue sky, it would probably be more conspicuous than any other color. This was qualified by the observation that yellow blades against a background of plowed fields, etc., could scarcely be distinguished. Dr. Leffmann also thought that it was perhaps a mistake that color was ever employed. To be able to judge the signals by their position only, he believed, would be an advantage. Whether this statement was meant to apply to all signals is not quite clear.

Electric Motors for Railways.

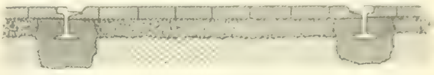
Exception is taken by the *Railroad Gazette* (August 9) to the construction placed by the daily press upon the recently-announced arrangement between a great electrical manufacturing company and an equally great locomotive-building works for the supply of certain parts of the same machine by each works. As a matter of fact, the newspapers did have some rather extreme "scare heads," such as "an industrial combine," "a combination of millions," "big industries in alliance," "great companies unite," and so on. The *Gazette* explains that "the simple fact is that these two companies have made an arrangement under which they will unite in developing electric motors suitable for railroad work. The resources of both establishments will be utilized in design, experiment, and determination of standards in general and in detail. Further than that, orders which may be secured for engines of this description will be divided, each works doing that part for which it is fitted by plant, skill, and experience." The *Gazette* goes on to say that "it is an obvious waste of energy for the electric works to build frames, running gear, and all that part of motors and electric locomotives which the locomotive works are especially qualified to to, and which they are likely to do a great deal better than any one, however skilful, coming new into the field. On the other hand, it would be an obvious waste of energy for locomotive works to put in additional plant and the additional staff necessary to make the strictly electrical equipment for such machines. Therefore, combinations such as have been made between the Baldwin and Westinghouse companies are in the direction of economy of energy, and for the interest of the parties immediately concerned, and of the great public."

The New York *Times* (August 10), commenting on the foregoing, again lays stress on the importance and meaning of the arrangement, and, after referring to the few existing ventures into the realm of heavy electric railroad work (the Nantasket Beach road, the powerful electric motors of the Baltimore & Ohio, and those on one short branch of the Pennsylvania system), presents a well-considered discussion of that much-mooted question,—how far electric haulage is to encroach on steam in railroading. A favorable, though conservative, view is taken.

Track Construction Without Ties.

THIS might seem almost an absurdity, but such a track has been laid on 1½ to 2 miles of a street railway in Detroit, and has been tried so long that it can hardly be considered a novelty. The system is briefly described in the *Street Railway Review*, from which the accompanying cut is copied.

The rail is laid without ties by making trenches 1 ft. wide, and deep enough to allow 6 in. of concrete to be put under each rail. Tie rods are put in every 10 ft., but these are not "ties" in the usual sense. A 7-in. girder rail is used. This system of construction is claimed to be suitable to streets which are permanently paved before the tracks are laid. The pavement most suitable is asphalt or brick, as this class allows the concrete to come much nearer the top of the rail than pavements with deep blocks. A similar method of construction has been employed in Montreal and Toronto for 2 years, and is said to have given good satisfaction. It is a radical departure from all established methods.



TRACK WITHOUT TIES

A Railway Race in Great Britain.

A NOTABLE speed competition has been inaugurated between the companies using the east and west coast routes from London to Scotland, this time the objective point being Aberdeen, instead of Edinburgh and Glasgow as in the famous struggle of 1887. *Engineering*, of August 2, contains a carefully-prepared analysis of the situation, and gives the history of the remarkable accelerations in speed attained by the competing lines. It must be remembered that the times given are on regular daily schedule, and not exceptional single runs. As to the question whether such racing is advantageous to the public, and what its value is to the engineering profession and to shareholders, *Engineering* makes some pertinent remarks. For one thing, each company has its prestige to maintain; otherwise public support is withdrawn. To the possible suggestion that amalgamation of the competitors would result in economy, *Engi-*

neering answers that the British public has a most steady inclination in favor of competitive railroads. "Moreover," it adds, "progress requires such competition." Again, as is shown by a graphic chart, permanent acceleration follows such contests. At the same time, economy in working becomes, with keener competition, a necessity, so that ingenuity towards this is stimulated. On these grounds, *Engineering* concludes, there is a measure of permanent good, even to the shareholders, which cannot accurately be measured. That racing is advantageous to the general public our authority believes to be undoubted—and it might have added invidiously here that the solid construction of British roadbeds and careful precautions against accident allow the extreme powers of the engine to be put forth without additional danger.

In the great contest of 1887 the time between London and Edinburgh was cut down in a few weeks—by successive shortenings of from half an hour to a few minutes, first on one line, then on the other—by 2 hours in all, on a journey of 400 miles, which meant a gain of 20 per cent. and a regular schedule rate of 54 miles per hour, including all stops and notwithstanding grades. As a matter of fact, the final achievement was an average speed, including stoppages, of from 56 to 58 miles an hour. But, as *Engineering* observes, the achievements of to-day are the commonplace performances of to-morrow, and the extreme 1887 speed—7 hours 27 minutes from London to Edinburgh—has been lately matched by a regular timetable rate of 7 hours 30 minutes.

At present the main contest is on the London-Aberdeen runs, 540 miles by the west coast and 523 miles by the east,—much longer and more difficult runs than the run to Edinburgh. On August 1 the trains were running the whole distance, including stops, at the following average speeds: west coast, 52.8 miles; east coast, 49 miles; while on the preceding day a train on the London and North-western and Caledonian lines had made the brilliant record of 54.09 miles, through average, which *Engineering* pronounces to be unparalleled in Great Britain for a run of 540 miles with such gradients. The trains, it is true, are comparatively light. Those on the Aberdeen service now consist of six to eleven 8-wheel bogie carriages,—train weight 130 to 175 long tons.

The First Inside Locomotive.

G. A. SEKON in *The Railway World* for June finds this question is variously answered, and there is still a doubt in some minds as to whether priority should be awarded to Edward Bury, Robert Stephenson, or Timothy Hackworth. The "Liverpool," built by Bury, the "Planet," built by Stephenson, and the "Globe," built by "Hackworth," were all constructed in 1830. All three were inside cylinder machines, but who is entitled to the credit of the idea? Yet, with two exceptions, the standard authorities award the honor to Bury; and Mr. Sekon cites a long list of proofs to establish the truth of this conclusion. Among these is a statement made by Peter Lecount, a well-known railway official, and a personal friend and fellow officer with Bury on the London and Birmingham Railway, who says: "The first engine made by Bury was the 'Dreadnought,' which started on the Liverpool and Manchester Railway March 12th, 1830. The next was the 'Liverpool.' This was the original engine made by him, with horizontal cyclinders and cranked axles. She was placed upon the Liverpool and Manchester Railway on July 22d, 1830, and had an 18-in. stroke, 12-in. cylinders, and two pairs of 6-ft. coupled wheels." Lecount goes on to describe the first eight engines built by Stephenson for the Liverpool and Manchester Railway, of which he writes: "They had the cylinders outside the boiler, and worked by a crank pin on the wheel. Mr. Bury's engine, the 'Liverpool,' was then constructed for that railway, and about four months after it had been placed upon the line Mr. Stephenson adopted the crank axle and placed the cylinders horizontally, with the improvement of putting them inside the smokebox. This was done first to his engine, the 'Planet,' which was placed upon the railway Oct. 4, 1830,"—three months' priority.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English [illegible] Journals—See Introductory.

*5. The Modern Problem of Grade Crossing. Ill. William O. Webber (Experience and practice in New England). Eng Mag–Sept. 3000 w.

26. Brake Shoe Material. Editorial (Comparison of brake shoe material on basis of wear, frictional quality and price). Ry Mas Mech–July. 800 w.

43. Principles vs. Precedents (Editorial. Business side of transportation). Ry Rev–July 6. 800 w.

55. The Electric Systems of the North and West Chicago Street Railroad Companies. Ill. Edward M. Hager (Descriptive of track construction, electrical construction, power houses and car equipment). W Elec–July 6. 5200 w.

56. The Nantasket Electric Road. Ill. (Details of construction and equipment of an advanced example of suburban electric railway). Elec Rev–July 3. 2500 w.

57. The Substitution of Electricity for Steam in Railway Practice. Inaugural Address by Dr. Louis Duncan, A. I. E. E., Niagara Falls, June, 1895 (Able discussion of respective limitations of steam and electric transportation). Elec Rev–July 3. 5000 w.

58. Tests of a Combined Electric Light and Electric Railway Central Station. Ill. Dugald C. Jackson and Arthur W. Richter (Paper read before the A. S. M. E., Detroit, June, 1895). Elec Rev–July 3. 3400 w.

*61. Railway Companies' Savings Banks. C. H. G. (Detailed information about this institution and others of like character). Bank Mag, Lond–July. 1300 w.

65. The Baltimore Belt Line Tunnel. Ill. (A description of the tunnel and the electric power station which furnishes current for the big electric locomotives). Elec Rev–July 10. 2500 w.

73. New Wabash Shops of the C., C., C. & St. L. Ill. (Descriptive). R R Gaz–July 5. 1000 w.

74. Electricity on the Railroads (Editorial. Conservative estimate of competition). R R Gaz–July 5. 1300 w.

76. The Tehuantepec Railroad—Its importance as a Competitor for Transcontinental Traffic (Corr. Present condition, outlook and advantages). Ry Age–July 5. 2800 w.

77. Compound Locomotives—Experience of Experts (Free discussion at the recent Master Mechanics Association. Generally favorable to the compound system). Ry Age–July 5. 1900 w.

78. Report on Air Brake Tests by Committee of Master Car Builders Association. Ry Age–July 5. 2000 w.

83. Freight Traffic on Electric Railways. Ill. (Special traffic examples; combination cars; market cars; mail service). Eng News–July 11. 2000 w.

87. Freight Stations and Yards on English Railways. Abstract of Report by George H. Turner. Ill. (Arrangement; system of handling). Eng News–July 11. 5000 w.

95. The Intercontinental Railway Commission. E. Z. Steever (Secretary's Report. Conference of 1889; organization; projects). Sci Am Sup–July 13. 2500 w.

112. The Terminal Improvements at Providence. Ill. (Site; bridges; station). R R Gaz–July 12. 2500 w.

113. Concord and Montreal 8-Wheel Passenger Locomotive. Ill. (Dimensions; weights). R R Gaz–July 12. 350 w.

114. Mr. Aspinall on Express Locomotives. (Review and abstract of paper read at International Railroad Congress, with editorial. Types for high speed; simple and compound engines; slide valve; permanent way). R R Gaz–July 12. 2800 w.

115. Car and Train Loading. Condensed paper by M. W. Mansfield (Mathematical formulæ). R R Gaz–July 12. 1100 w.

116. American and English Locomotives in Japan (Comparative tests). R R Gaz–July 12. 900 w.

117. Track Laid in the United States to July 1 (Detailed statistics). R R Gaz–July 12. 1000 w.

118. The Physical Condition of Railroads (Editorial. Need of fuller reports). R R Gaz–July 12. 600 w.

119. Railroad Organization (Abstract reports of International Railroad Congress). R R Gaz–July 12. Serial. 1st part. 2000 w.

154. Railway Receiverships and Foreclosures in 1895 (Editorial. Statistics; comments). Ry Age–July 12. 900 w.

155. The Electric Problem (Steam roads using auxiliary electric power). Ry Age–July 12. 400 w.

156. Transcontinental Railways in Mexico and Central America. Map (Proposed routes; distances). Ry Age–July 12. 1600 w.

160. Sixty-foot Rails (Favorable tests). Ry Rev–July 13. 400 w.

161. The South Indian Railway. Ill. Clement F. Street (Shops; Engines; cars). Ry Rev–July 13. 800 w.

162. The Staff System. A. H. Rudd (Block System for intervolved bridge tracks). Ry Rev–July 13. 400 w.

163. Does It Pay for Railways to Operate Their Own Brass Foundries. Discussion (Arguments pro and con; limitations). Ry Rev–July 13. 1000 w.

*175. The Effect of Temperature on the Strength of Railway Axles. Thomas Andrews (High and low temperature; axles, tires, rails). Engng–July 5. 2500 w.

*176. Rolling Stock for Express Trains. Abstract. C. A. Park (American, English and other types; construction; details). Engng–July 5. 6200 w.

182. Special Track Work for Electric Street Railways, Especially Referring to the Montreal and Toronto Systems. Ill. E. A. Stone (Goes extensively into details from, and including the general survey, to the shop work and the track laying). Can Elec News–July. 5000 w.

*217. The International Railway Congress (Editorial comment on discussion of papers). Eng, Lond–July 5. 5000 w.

*223. Electric Traction. Ill. Full abstract of paper by M. Auvert (Classification and description of type systems). Eng, Lond–July 5. Serial. 1st part. 5800 w.

227. Niagara Falls River Railroad. Ill. (Trolley, water and steam power). Fire & Water–July 13. 700 w.

*248. The International Railway Congress (Discussions ; strengthening permanent way ; signaling ; fast freight ; light railways ; decimal and metric accounting). Trans–July 5. 7000 w.

*249. The American Interstate Commerce Commission (Summary and comments on report). Trans–July 5. 1000 w.

*260. Electric Track Drill at South Chicago. Ill. (Time-saving). St Ry Rev–July 15. 500 w.

*261. Iron Clad Cars. Ill. J. W. Greer (Construction ; advantages). St Ry Rev–July 15. 1200 w.

*262. The Lenox Avenue Conduit Road, New York. Ill. (Underground trolley ; details). St Ry Rev–July 15. 1500 w.

*265. A Run on a French Compound Express Engine. Ill. A. M. B. (Reversing gear ; firing; speed ; signals ; 2 decked cars). Ry Wld–July. 1600 w.

*266. Havre Electric Tramways. Ill. Also Editorial (Line ; power station ; rolling stock). Ry Wld–July. 800 w.

*267. The Central London Railway. Ill. (Projected underground electric line, route ; financial). Ry Wld–July. 900 w.

268. Revision of the Rules of Interchange, with Editorial (Changes in new M. C. B. rules). R R Car Jour–July. 2800 w.

269. Statistics of the Railroads of the United States for Year Ending June 30, 1894 (From Interstate Commerce Commission Report). R R Car Jour–July. 250 w.

270. Anatomy of a Freight Car. Ill. (Plate showing 143 principal parts). R R Car Jour–July. 1500 w.

271. The Per Diem System and the Movement of Cars in Interchange (Correspondent's criticism of report of Car Service Committee, Am. Ry. Asso). R R Car Jour–July. 1700 w.

272. Reports Presented to the Master Car Builder's Convention (With discussion on interchange of cars ; mounting new and second hand wheels ; air-brake apparatus and tests ; brakeshoe road tests ; laboratory tests ; lubrications of cars ; coal-car sides ; passenger platforms). R R Car Jour–July. 50500 w.

278. The Problems of Electric Railway Work. Oscar T. Crosby (Abstract of interview published in New Orleans Times Democrat. Frequency of service the real test). Elec Eng–July 17. 2000 w.

*292. The Trolley and the Death Roll. Townsend Wolcott (The immediate cause, or causes, and the remedy). Elec Pow–July. 2800 w.

†298. The Coming Railways of India and Their Prospects. Abstract. J. W. Parry. Ind & East Eng–June 15. Serial. 1st part. 1000 w.

345. Metallic Railway Ties. Ill. (Different styles ; sections). Ry Rev–July 20. 2000 w.

348. New Jersey Electric Railway Company. Ill. (Describes power house and line). Elec Ry Gaz–July 20. Serial. 1st part. 1000 w.

356. Permanent Way. William Hunt (Abstract of report on the strengthening of permanent way with a view to the increased speed of trains. Details. English system). Engng, Lond–July 12. Serial. 1st part. 5000 w.

*357. Railway Congress—Signals (English block system. Résumé of Mr. Thompson's report). Eng, Lond–July 12. 1600 w.

*358. Very Light Railways on the Continent (Narrow gauge). Eng, Lond–July 12. 1700 w.

*363. The International Railway Congress (Col. Haines interviewed. Contrasted systems). Trans–July 12. 5500 w.

367. From Daily Report of the Illinois Central Railroad. Ry Age–July 19. 200 w.

368. Car and Train Loading. M. W. Mansfield (Mathematical analysis). Ry Age–July 19. 2000 w.

*388. Railway Communication between Europe and India (Suggested routes). Bd of Tr Jour–July. 1100 w.

408. Reversing Locomotives in Emergency Stops (Tests). Eng News–July 18. 1200 w.

*422. Experiments on the Lubrication of Bearings Made on the Paris-Lyons-Mediterranean Railway. Mech Wld–July 19. 1200 w.

426. Track for Heavy Locomotives (Safety ; maintenance ; details). Eng News–July 25. 1200 w.

432. Iron and Steel Railway Ties (Conflicting opinions). Am Mfr & Ir Wld–July 26. 800 w.

437. The Commercial Efficiency of Heavy Locomotives (Comparative results on So. Pac. R. R). R R Gaz–July 26. 1700 w.

440. Developing of Automatic Signaling in the United States (Abstract of paper by A. W. Sullivan, read at Int. Ry. Con). Ry Rev–July 27. 1000 w.

442. Reversing Locomotives in Emergency Shops (Conclusions from experimental tests—with editorial). Ry Rev–July 27. 1200 w.

446. Street Railway Statistics (Criticism of statistics). Ry Age–July 26. 700 w.

447. The Miller Interlocking and Block Signal System. Ill. (Automatic danger or clear signals in cab). Ry Age–July 26. 1100 w.

*459. The Railways of India (Statistics). Trans–July 19. 1900 w.

*476. History of the Metropolitan Railway. Ill. (Problems of gauge, rolling stock, brakes). Eng, Lond–July 19. Serial. 1st part. 3700 w.

*478. Some Remarkable Performances by British Locomotives. Charles Rous-Marten (Actual service records). Eng, Lond–July 19. Serial. 1st part. 4500 w.

*481. The New Underground Railway in Glasgow (Tunnel construction; walls, roof). Engng–July 19. 3800 w.

†520. Railway Construction on the Peruvian Andes. James R. Maxwell (Local conditions; historical; steep gradients. Discussion). Pro Eng Club of Phila–July. 4800 w.

†522. Certain Interesting Features in the Manual Interlocking of Railroads. Ill. George H. Paine (Evolution; mechanical details; signals). Pro Eng Club of Phila–July, 5500 w.

†523. The Philadelphia and Reading Coal Storage Plants. Ill. William D. Beatty (Level-floor system; chain conveyors; portable boom conveyors). Pro Eng Club of Phila–July. 5500 w.

†532. The New Jersey Electric Railway Company. Ill. (Track; overhead construction; power stations; car houses; rolling stock). St Ry Jour–Aug. 4400 w.

†533. Gauging Wheels and Wheel Gauges. (Design of gauge for car wheels). St Ry Jour–Aug. 700 w.

†534. Important Suggestions Regarding Wheels. Ill. (Effect of chilling; street car and motor wheels). St Ry Jour–Aug. 2400 w.

†535. Causes for Removal of Wheels. (Proportions; different defects; street car wheels). St Ry Jour–Aug. 500 w.

†536. Motor Car Wheel Mileage. W. E. S. (Record of different makes). St Ry Jour–Aug. 1500 w.

†537. Purchase and Care of Street Car Bodies. George B. Hendrick (Practical hints). St Ry Jour–Aug. 900 w.

†541. The Central London Railway. Ill. Alex. McCallum (Deep tunnel electric road). St Ry Jour–Aug. 2000 w.

*547. The Tehuantepec Railroad (Its importance as a competitor for transcontinental traffic). Am Eng & R R Jour–Aug. 2300 w.

*549. Wrecking Car—Central Vermont Railroad. Ill. (Framing; boom derrick). Am Eng & R R Jour–Aug. 700 w.

553. Louisville, New Albany & Chicago Ry. Co.'s Lafayette, Ind., Shops. Ill. (General arrangement; construction; details). Eng News–Aug. 1. 1700 w.

556. The Renewing of Worn Steel Rails (Plant and method of re-rolling and trimming). R R Gaz–Aug. 2. 1300 w.

558. Needed Reforms in Handling Freight Cars (Extracts from address of L. F. Loree, at Car Service Managers' Convention). R R Gaz–Aug. 2. 1100 w.

559. The Shay Locomotive. Ill. (Dimensions; elevation; tender sections). R R Gaz–Aug. 2. 550 w.

560. The Railroads of the World (Statistics by countries). R R Gaz–Aug. 2. 350 w.

582. The Policy of Railroad Consolidation. Letter from Mr. Samuel Spencer in reply to Transportation Committee, with editorial comment). Ry Age–Aug. 2. 2200 w.

†584. The New Overland Route Across Arabia. Ill. A. F. (Comments on article in Contemporary Review; assured future). Ind Engng–July 6. 1600 w.

*608. American and English Locomotives in Japan (Comparative dimensions; coal consumption). Ind & Ir–July 26. 1000 w.

*611. The Development of China and Japan (Railroads; gauge; bridges; tunnels). Ir & Coal Tr Rev–July 26. 2200 w.

615. Time Required to Stop Trains by the Air Brake (Graphic chart from tests). Am Mach–Aug. 1. 900 w.

617. Master Car and Locomotive Painters' Convention (Queries on painting and cleaning). Ry Rev–Aug. 3. 1300 w.

618. New Philadelphia and Reading Passenger Locomotive. Ill. (Compound; new features). Ry Rev–Aug. 3. 400 w.

619. Automatic Block Signaling with Reference to European Requirements. F. A. Delano, with Editorial Comments (Paper presented before the International Railway Congress). Ry Rev–Aug. 3. 2200 w.

626. Electrical Equipment of the Mount Holly Branch of the Pennsylvania Railroad. Ill. (Descriptive). Elec Rev–Aug. 7. 1000 w.

637. New Electric Railway. Statement of A. D. Anderson (A projected air line from Washington northward to Gettysburg). Mfrs Rec–Aug. 2. 1500 w.

647. Baltimore and Ohio Railroad Tunnel at Baltimore. Ill. (Descriptive). Sci Am Sup–Aug. 10. 4000 w.

650. Recent Progress in Railway Signaling. A. M. Thompson (Paper presented before the International Railway Congress). Eng News–Aug. 8. 2500 w.

652. New Types of English Locomotives. Ill. (Details of dimensions, etc). Eng News–Aug. 8. 1000 w.

668. Street Railway Company Cannot Use Competitors Tracks Without Express Authority (Decision in the suit of chancery in Chicago). W Elec–Aug. 10. 1000 w.

*675. Rate Cutting on American Railways (A chat with Mr. Chauncey Depew). Trans–Aug. 2. 1400 w.

677. Lead for Locomotives. C. H. Quereau (It is the opinion of the writer that a proper adjustment of lead will slightly improve the coal record, but that its chief advantage is a saving in repairs and time lost by engine failures). R R Gaz–Aug. 9. 2800 w.

678. The Reading's Single-Driver Express Locomotive. Ill. (What the engine has done and why. Description and dimensions). R R Gaz–Aug. 9. 1800 w.

680. A Failing Case in Station Design (Editorial consideration of error in design of the larger stations of the United States). R R Gaz–Aug. 9. 3300 w.

SCIENTIFIC MISCELLANY

An Innovation in Printing.

THE *Home Journal*, one of the oldest of American weekly literary newspapers, in its issue of Aug. 7 discusses an innovation in printing which was initiated about a year ago by *Liberty*, a paper which is devoted to the dissemination of the principles of Philosophic Anarchy, and which, however anyone may be disposed to dissent from its teachings, is edited with care and skill that must command the respect of all competent critics. The innovation alluded to is the abolition of a convention in printing technically called "justification." To "justify" lines in printing when setting the type is to make the lines of type all of the same length. It is a convention, pure and simple, and applies only to prose composition. The compositor, when he approaches the end of a line of type and finds that he cannot insert another complete word or syllable, takes out spaces from between the words already set and substitutes thicker spaces (spaces are strips of metal shorter than, but of the same width as, the types) until the line is made of the same length as that of the lines previously composed. This operation requires care and taste, and in high-class work consumes, as computed by *The Home Journal*, two-sevenths of the entire time required for the composition; that is to say, if a printer can set in a given time five thousand "ems" when required to "justify" the lines, he could, without "justifying," set seven thousand "ems." The time consumed in justifying is, according to this computation, two-fifths of that required for the actual type-setting, or 40 per cent. We have not verified this statement, said to have been based on actual experiment, but it appears entirely probable, and may, we think, be accepted as fact. A further computation shows that this percentage of needless work represents in the civilized world "the productive power of the labor of two hundred thousand people."

"Supposing that in the entire world there are six hundred thousand people engaged in type-setting (probably a conservative estimate), the amount of work which they now perform could be performed, by the new method, by a little more than four hundred thousand people. From this, one of two things would result: either the remaining two hundred thousand would engage in other pursuits and add to the world's wealth in that way, or else, the price of printing falling, the demand for it would so increase as to keep the entire six hundred thousand at work, thus increasing the world's literary product by nearly 50 per cent. The prices of books and periodicals would fall materially, and the opportunities for education would be correspondingly increased.

"This typographical reform would also work to the advantage of the people by enabling them to get the benefit of the type-setting machine without paying the inventor a monopoly price for it. If the machine effects a saving of 50 per cent. in comparison with ordinary hand composition, the inventor, while his patent runs, will allow 5 per cent. to the people and keep 45 per cent. to himself. But, if the people are in a position to say to the inventor that, instead of accepting his 5 per cent., they can save 30 per cent. by adopting the new method, he will immediately offer them 35 per cent., keeping only 15 per cent. for himself. Probably in the rough work of the daily newspaper, where alone as yet the machine plays an important part, the new method would save only 15 instead of 30 per cent., since the daily press takes less care to secure accurate 'justification'; this fact, however, does not affect the validity of the above argument. The inventor in that case would offer 20 per cent. to the people and keep 30 per cent. for himself. In this connection it is well to note that the supposed necessity of 'justification' has been the chief obstacle in the way of machine composition. The machine that 'justifies' automatically is of very recent date. But machines were invented long ago that would set type without 'justification,' so that, were it not for the reverence in which we hold a straight edge, hand composition would now be a thing of the remote past."

The fact is that the custom of "justification" in prose printing rests upon no rational foundation whatever. In printing blank verse lines are not justified, but, if we sought reasons for the custom, we could find as many for "justifying" blank verse as for prose. As to the appearance of a page printed without "justification,' we have only to open a copy of Shakspere or Milton to find it and compare the pages with those of an ordinary prose book. We shall, on making such comparison, probably wonder at the persistence of the practice of "justification," for we certainly shall find no hint of its necessity. As a matter of fact, it is utterly arbitrary and useless.

How columns in a newspaper would appear without "justification" any one who has access to a copy of *Liberty* can see, as that paper does not "justify" its lines. An example of the effect is also given in *The Home Journal* article. Beyond the slight impression of oddity which is felt at first, as when one puts on a new hat, there is no feeling of anything incongruous or inartistic. If a page or column were really more artistic or beautiful with lines "justified," that would be a sufficient reason for perpetuating the custom; but some of the most beautiful books in existence are volumes of blank verse,—a fact which proves the contrary.

It is, however, admitted, in the conclusion of the argument, that the change advocated is not an easy one to bring about. "No journal, unless it be one which especially appeals to friends of innovation, could adopt this new method of typography without subjecting itself to a degree of ostracism which no commercial enterprise finds it expedient or safe to incur."

To the North Pole in a Balloon.

THE mere fact announced in *Nature* (July 4) that M. Andree, a Swedish engineer, has proposed to reach the North Pole in a balloon is, of itself, not important, as such a proposal is not unprecedented. The fact worthy of note in connection with the project is that the details of the proposed attempt have been so carefully considered from the practical side by a man accustomed to meet and overcome difficulties as to command the attention of one of the most learned and scientific societies in Europe,—the Royal Society of Sciences at Stockholm. *Nature* states that M. Andree has had "much experience in polar regions, having spent the winter of 1882-83 in the far north, and also taken part in the Swedish meteorological expedition, which lasted a year. He has also proved himself to be a dauntless aeronaut, his most interesting voyage being one from Gothenburg to the Isle of Gothland, in which he had to cross part of the Baltic. Everything in connection with this proposed expedition has been minutely studied and discussed, and infinite pains have been taken to solve all difficulties.

"The balloon would require a double outer covering, and a volume of 6500 cu. yds. The ascensional power thus obtained would be sufficiently great to carry three persons, furnished with provisions for 4 months, besides allowing for the car being fitted up with necessary instruments for observation, life-buoys, and Berton's collapsible boats. The car could be suspended in such a way as to allow of instant detachment in case of a descent into the sea. The entire weight of balloon must not exceed about 3 tons. In the instance of Henri Giffard's captive balloon, exhibited in 1878, and which weighed about 6 tons, it only required newly inflating after a year's use. According to Graham's observations, a balloon measuring 8¾ yds. in diameter can be made sufficiently air-tight to suffer, per month, merely a loss of 13½ lbs. of its ascensional force. M. Andree, however, hopes to produce an absolutely impermeable covering.

"The balloon, being protected from the wind by a wooden enclosure, would be inflated as far north as possible, by means of hydrogen compressed in cylinders. This once accomplished, it would begin to ascend. To a certain extent it might be steered by means of a sail and several guide-ropes, which, dragging on the earth, forms, as it were, a brake. The ropes, however, would have to be of special composition in order to produce the same effect in water. The hindrance thus caused to the flight of the balloon, together with the pressure of the wind, would allow the use of a sail. The flight then might be an angle of 40° away from the wind direction. This steering apparatus, invented by M. Andree, has often been used by him in his aerial voyages.

"Besides the guide-ropes, heavy lines, on which would be placed numbered metal plates, would be attached to the car; these would serve as ballast. In case of a lowering of temperature and a consequent descent of the balloon, it could be lightened by throwing off these plates, which, if found, would, to a certain extent, show the course taken by the explorers."

July is named as the proper month for starting, and Spitzengen as the point of departure. A clear day should be selected, when a clear southerly wind is blowing. At this point such a wind has a mean velocity of 10½ yds. per second; but the proposed guide ropes would reduce the velocity of the balloon to 7½ yds. per second, at which rate it is computable that, if the balloon makes a reasonably straight course, the pole would be reached in 43 hours from the time of starting. At the mid-summer season it is stated that the temperature at Cape Thorsden ranges from 8° C. to 11° C.; that there are practically, no storms; and that only very light snowfalls come in June and July. It is further stated by *Nature*, which draws upon *Revue Scientifique* for the details, that the project has been approved by some of the most experienced Arctic explorers. How, after reaching the pole, the return is to be accomplished is not stated.

The Charlottenburg Mechanical Testing Stations.

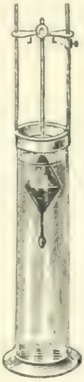
THE *Physikalisch-Technische Reichsanstatt* is the euphonious German name of a testing station at Charlottenburg, near Berlin, which *Engineering* (July 19) says "is to a certain extent the realization of Professor O. Lodge's desideratum of a national laboratory." This testing station is said to be "popular amongst the manufacturers and purchasers of technical apparatus and articles, because they can have the articles tested by competent and impartial men at moderate charges. And it is held in high esteem by men of science, because there experiments can be carried on which may require a lifetime, the coöperation of several investigators, and the continued use of costly apparatus. An official testing station is now to be found in every larger German town, in connection with its university or technical college. Some towns can boast of more than one technical college, and of more than one testing station. Thus Charlottenburg and Berlin possess, in addition to the Reichsanstatt, where Professor Fr. Kohlrausch has succeeded the great Helmholtz as president, and besides other institutions of this class, the Machanisch Technische Versuchs-Anstatt, which has for some time been directed by Professor A. Martens.

"This last institution is divided into four departments, each with its chief, all of which appear to be amply supplied with the requisite machinery and apparatus. The last department is devoted to the testing of metals, ropes, belts, and also wood. The test-pieces, which are not generally received of exact dimensions, can be prepared in the laboratories, their various strengths ascertained; they can be punched, planed, crushed, welded, cast, alloyed, etched in acid baths, microscopically examined, and photographed, and polished sections or slices tested in reflected and transmitted light. For these latter purposes a micro-photographic apparatus has been designed and constructed by Professor Martens and Mr. Carl Zeiss, of Jena. Special arrangements have been made for long-continued and repeated bendings, stretchings, &c., of discs, wires, and cables. In some tests specimens of over 50 ft. length and 30 in. width can be dealt with; polished surfaces can be made in areas of several square feet. In the second department building materials are examined,—natural and artificial stones, glass, wood, roof felting (a kind of paper is used in Germany as such), lime, cement, mortars, plasters, and drain-pipes. There are appliances for continued heating and freezing, treating in the wet, and other means of imitating the effects of ordinary wear and tear. The question of cement testing has long been recognized as one of public interest in Germany, and for some years this mechanical testing station at Charlottenburg has been acknowledged as the final arbitration court of the government. For a complete cement test 2 tons of the material are required; weights of less than 20 lbs. are not accepted even for ordinary experiments. The third department, shortly known as the paper department, inquires into paper, cardboard, canvas, tarpaulin, threads, and textile fibres in general. It is particularly requested that the specimens of paper should be packed between thick covers of cardboard, in order to avoid creases and the pressure of the postal mark. The fourth department deals with lubricants; Professor Martens is an authority on such matters.

"All these testing stations are under the superintendence of a government board. Pamphlets are issued, stating the way in which specimens should be selected, handled, packed, &c. They also give a summary of the various tests in use, and the charges made for these. The Charlottenburg list of tests comprises 419 numbers. Clients have to say, when submitting their specimens, what they wish to be done. If in doubt about the best way in which to obtain their aims, they are advised to communicate with the director. By request, experiments are conducted on the special lines desired; the certificate issued in such a case contains a notification to this effect. Prepayment is the general rule. For investigations which will occupy a long time a deposit is demanded, and a discount, varying from 10 to 20 per cent., allowed. The same facilities are offered to firms which frequently consult the testing station. The chemical laboratory in the Invalidenstrasse, Berlin, which is connected with the Mining Academy of Berlin, makes a specialty of ink and fuel testing, besides undertaking general analyses, more particularly of inorganic substances. Since 1889 the supervising board of the Prussian testing stations has published 'Mittheilungen' on the work done and experience gained. These journals contain valuable information, and the apparatus originated in these laboratories can be freely copied."

A Novel Chemical Balance.

THIS is a balance for weighing very small quantities of substances. It acts on the principle of the well-known hydrometer. It is the invention of Mr. H. Joshua Phillips, F. I. C., F. C. S., a consulting chemist, and is illustrated and described in *Engineering* (June 14).



"It consists of a glass cylinder, upon the top of which can be fixed a portable brass ring containing two upright guide rods of brass 6 in. high and ⅛ in. in diameter. The balance proper consists of gilded brass bulbs, into which is screwed an aluminum stem. Screwed on to the top of the stem there are arms, also of aluminum, which are perforated at each end so that the guide-rods can pass through them. Upon the centre of the arms there is a receptacle for a small aluminum scoop or pan to hold the substance to be weighed. Underneath the arms, it will be seen, there are projecting needle-points; there is also a movable point upon one of the guide-rods. The manner of using the instrument is as follows: the cylinder is first filled with cold recently-boiled water; the bulbs and attachments are then dropped in, the guide-rods passing through the perforations of the arms. The balance sinks into the water until the bulbs are just covered. Supposing 0.2 gramme of steel drillings are desired to be weighed. A 0.2 gramme weight is dropped into the portable pan; the bulbs then sink to a definite depth, which can be ascertained by bringing the movable needle-point upon the guide-rod so as to face the point fixed upon the arm. The weight is now taken off, and the bulbs rise again. The sample of steel drillings is now gradually introduced into the empty pan until the needle points are again opposite each other,—gently tapping the instrument to remove any friction,—and the 0.2 gramme of steel is thus quickly obtained. The range of weight that such an instrument is capable of recording must of necessity be of narrow limits. The depth to which the instrument will sink in the liquid with a given weight, and also its delicacy, will depend upon the diameter of the stem. The diameter of the stem of the balance shown in the sketch is $\frac{1}{16}$ in., and a load of 0.2 gramme will sink it about 3⅞ in. The height of the cylinder is 10 in., and its diameter 1⅞ in., and the total length of the stem 5½ in. An instrument of these dimensions will be found useful for weighing steel for carbon tests, &c., and also for weighing certain precipitates, &c."

The Kauri Gum Industry in New Zealand.

THE New Zealand Official Year Book has an article on this subject, reprinted in *The Colliery Guardian*, of which we make the following abstract:

The kauri gum is not chemically a gum, but a true resin. It is the solidified turpentine of the kauri, and occurs in great abundance in fossil condition in the northern part of the Auckland provincial district, from the North Cape to Middle Walkato, and is dug up alike on the driest fernhills and the deepest swamps. The purest samples are found on the Cape Colville peninsula. A large quantity is also obtained from the forks of living trees, but is considered of inferior quality and fetches a lower price. At the present time gum-digging employs nearly, or quite, 7,000 persons, including Maoris and aliens. In the fossil state kauri resin occurs in larger or smaller lumps, from the size of a walnut to that of a man's head. Pieces have been found weighing upwards of 100 lbs. When scraped, the best specimens are of a rich brown color, varying greatly in depth of tint. Sometimes translucent, or even transparent, specimens are found, occasionally with leaves, seeds, or small insects enclosed. When obtained from swamps, the resin is very dark-colored, or even almost black, and fetches a low price. Waikato resin is the darkest of all. Transparent, or semi-transparent, specimens fetch very high prices, being used as a substitute for amber in the manufacture of mouthpieces for cigar-holders, pipes, &c. The great bulk is used in the manufacture of varnishes, and in countries where much varnish is made it holds the chief place in the market. It is exported chiefly to England and the United States.

The digger's equipment is of simple character. A gum-spear (that is, a light, pointed iron rod, fixed in a convenient handle) is used to test the ground; the gum is then dug out with a spade and carried home in a sack. In many cases the spear is dispensed with, and the entire area is dug over to such a depth as the digger thinks likely to be profitable. An old knife is used to scrape the gum, the scrapings being utilized in the manufacture of fire-kindlers.

Gum-digging is a standing resource for the industrious unemployed, and has enabled Auckland to tide over periods of serious commercial depression with comparatively little difficulty. It has also been of vast benefit to hundreds of settlers with but small capital; not a few, who have attained a large measure of prosperity, look back gratefully to the help afforded by casual work on the gum fields. In the commissioners' report it is stated that the average earnings of the digger on leased or private land are 27s. per week, while the actual cost of living is from 10s. to 12s. As the digger has no difficulty in constructing a weather-proof hut, he is not called upon to pay house-rent; his fire-wood also is obtained free of cost, so that he clears from 15s. to 17s. per week above the cost of living. As a matter of fact, the industrious digger is in a more favorable position than the figures just given indicate, since the average earnings are unduly lowered by the presence of a number of old people, who have taken to the work, as well as of others who are content to live from hand to mouth.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

*3. Natural Science Training for Engineers. N. S. Shaler (A plea for a broader course in scientific instruction). Eng Mag–Sept. 2800 w.

†15. Sanitary Topography, Climate, and Mineral Springs of New York. A. N. Bell (Treated popularly with table of temperatures and rainfall and other meteorological data). San–July. Serial. 1st part. 1800 w.

†16. Report of Progress in Public Hygiene. S. W. Abbott (Relates largely to sanitation of shops and factories, but includes filtration of sewage and municipal sanitation). San–July. 3200 w.

†20. The History of a Recent Astronomical Discovery. A. W. Drayson (The author claims to have discovered an error in astronomical works with reference to the movement of the poles of the earth relatively to the poles of the ecliptic). New Sci Rev–July. 3700 w.

†21. Climate and High Altitudes. Henry Russell Wray (Relation of altitude to climate with reference to effect of climate upon pulmonary and other diseases). New Sci Rev–July. 1200 w.

†22. The Curvature of Space. John Dolman, Jr. (Discusses hyper space, or non-enclidean space, and the so called fourth dimension). New Sci Rev–July. 4200 w.

49. Dickerson's Process and Apparatus for the Production of Acetylene Gas from Calcium Carbide. Ill. (Copy of drawings, specifications and claims of patent granted to E. N. Dickerson, June 25, 1895). Am Gas Lgt Jour–July 8. 1300 w.

71. The Relation between Composition and Refractory Characters in Fire-Clays. H. Jochum. Am Mfr. & Ir Wld–July 5. 500 w.

†82. Reasons for Predicting the Existence of Argon. C. J. Reed (Mathematical discussion of atomic relationships). Jour Frank Inst–July. 2400 w.

98. Orthochromatic Photography. Ill. Sci Am Sup–July 13. 800 w.

99. The Depths of Space. Robert S. Ball (Reprint from N. Y. Sun). Sci Am Sup–July 13. 2200 w.

100. The New York State Fish Hatchery, Cold Spring Harbor. A. D. (Popular description). Sci Am–July 13. 1800 w.

105. Progress of Sulphuric-Acid-Making. A. D. Ledoux (History; evolution of plant and methods; recent improvements). Mfrs Rec–July 12. 1800 w.

†127. Magnesia in Portland Cement (Conflicting observations; temperature in burning). Ind Engng–June 8. 500 w.

†145. Recent Science. P. Kropotkin (Gives a history of the discovery and a review of the present scientific knowledge of the new elements, argon and and helium; the latter obtained now from Bröggerite as well as Clevéite. A review of the present status of electricity as related to meteorological science, and remarks upon the usefulness and practicability of Arctic exploration). Ninenteenth Cent–July. 9000 w.

†146. Color-Music. William Schooling (Suggests a new art that may appeal to the emotions through color, in a manner analogous to the effect of music, since both color and tone are sensorial effects of exterior wave motions). Nineteenth Cent–July. 3800 w.

†147. Some Lessons from Kiel. W. Laird Clowes (Aspects of importance to European nations both from the military and commercial standpoint). Nineteenth Cent–July. 6500 w.

167. Petroleum and Asphalt in Eastern Europe and Asia. Am Mfr & Ir Wld–July 12. 1300 w.

*170. The Rotation of the Earth. Ill. M. F. O'Reilly (Describes a repetition of Faucault's famous experimental demonstration of the earth's rotation performed at Trinity College, Dublin). Engng–July 5. 3000 w.

180. The Problem of Equipoise in Life. Abstract of address by James B. Angell (The individual as a member of society). Elec Engng–July. 1000 w.

183. The Sun. David P. Todd (Present state of knowledge pertaining to the sun. Astronomical; chemical; physical). Science–July 12. 6500 w.

190. Stones as a Source of Fertility. T. H. Hoskins. Gar & For–July 17. 1100 w.

*198. Argon and the Kinetic Theory. C. E. Basevi (A study in molecular physics and a correction of the equation whereby argon has been shown to be monatomic). Nature–July 4. 1200 w.

*199. Argon and Helium in Meteoric Iron. W. Ramsay. Nature–July 4. 1500 w.

*200. Proposed Balloon Voyage to the Pole. W. Nature–July 4. 800 w.

*201. The Relative Powers of Large and Small Telescopes in Showing Planetary Detail. W. F. Denning (Phenomenal results claimed to have been recently obtained with small telescopes). Nature–July 4. 2900 w.

*229. Technical Education Conference (Proceedings of Instruction Committees of various county councils, having for object the extension of the usefulness of the Society of Arts in technical education). Jour Soc of Arts–July 5. 10000 w.

*253. The Kauri Gum Industry in New Zealand (Statistics from Year Book). Col Guard–July 5. 1000 w.

287. Washington Timber (An estimate of available standing timber, suitable for lumber manufacture, in the Pacific Northwest). Sci Am–July 20. 1300 w.

*312. Division of the Bunsen Flame. Lewis T. Wright (On the induction of the explosive wave, and an altered gaseous condition in an explosive gas mixture by a vibratory movement). Gas Wld-July 13. 4500 w.

316. Petroleum and Asphalt in Eastern Europe and Asia (Localities in the world where found and local characteristics of products). Am Gas Lgt Jour-July 22. 1500 w.

*319. The Electrical Measurement of Starlight. George M. Minchie (System based on the electrical effect of starlight upon photoelectric cells. Measurements of electromotive force of the light of Jupiter, Saturn, Vega, Arcturus, Procyon, etc). Nature-July 11. 2200 w.

*321. Scientific Uses of Liquid Air. Prof. Dewar. Elect'n-July 12. 6000 w.

336. A $2,000,000 Plant. Developing a New Industry in Southwest Virginia. H. S. Fleming (Soda manufacture). Mfrs Rec-July 19. 1200 w.

*341. Report on Metric Weights and Measures (Professional opinions). Chem Tr Jour-July 13. 500 w.

*342. Marble in East Tennessee. Ill. (Topographical notes). Stone-July. 14800 w.

*349. The Dominion of Canada. Ill. W. H. Withrow (Descriptive. Cities; population, etc. Interesting article). Chau-Aug. Serial. 1st part. 2200 w.

*351. Land Wrested from the Sea. Martin Beck (The drainage of the Zuider Zee, The North Sea coast, and Baltic coast). Chau-Aug. 3200 w.

381. Photography in Natural Colors (System as explained by Dr. Joly at soiree of the Royal Society). From the London Times. Sci Am Sup-July 27. 1900 w.

ENGINEERING SOCIETY
SCHOOL OF PRACTICAL SCIENCE
TORONTO.

*392. Substitution of Teacher for Text-Book. J. M. Rice (An endeavor to point out where the weakness of teachers lies, and the remedy). Forum-Aug. 3200 w.

*394. The Drift of Population to Cities: Remedies. Henry J. Fletcher. Forum-Aug. 7000 w.

423. The Causes of the Gulf Stream. R. Meade Bache. Sci-July 26. 4400 w.

434. New Oil Fields (Penna., Ohio, W. Va). Am Mfr & Ir Wld-July 26. 800 w.

*460. Notes on Water Gas. George Ritchie (Abstract of paper read at the West of Scotland Iron and Steel Inst). Ir & Coal Tr Rev-July 19. 1800 w.

*480. The Mechanical Testing Station at Charlottenburg (General outline of this national laboratory). Engng, Lond-July 19. 700 w.

*483. Photometric Standards (Report of Board of Trade Committee). Col Guard-July 19. 1500 w.

498. The Iron Pillar near Kolab Minar, Delhi). Ill. A heavy forging of the 4th century). Ir Age-Aug. 1. 500 w.

507. The Manufacture of Artificial Limbs. Ill. (Processes; machines and tools). Sci Am-Aug. 3. 1200 w.

509. The Rawhide Cannon. Ill. (Government tests at Sandy Hook; construction). Sci Am-Aug. 3. [illegible]

†516. Argon. The New Constituent of the Air. John Tappan Stoddard (The discovery a masterly achievement). Pop Sci M-Aug. 2800 w.

†526. The Earth a Magnetic Shell. Frank H. Bigelow (Mathematical analysis; observatory data). Am Jour of Sci-Aug. 5000 w.

530. The Use of Hot Air in Drying. E. M. Cook (Practical and theoretical). Sci Am Sup-Aug. 3. Serial. 1st part. 2800 w.

531. New Combination of Argon: Synthesis and Analysis. M. Berthelot (Reprint of articles in Chem. News and Nature). Sci Am Sup-Aug. 3. 2500 w.

†544. The Ball Nozzle. Ill. Arthur Kitson (Gives an alleged explanation of the action of the device). Jour Fr Inst-Aug. 2400 w.

†545. Having the Logarithms of Two Numbers, to Find the Logarithm of Their Sum or Difference. Nathaniel Hill (Gives an alleged new method of solving this problem by use of a table of ordinary logarithms). Jour Fr Inst-Aug. 700 w.

*551. Speed in Migratory Flight of Birds. Karl Mills (Condensed from the Proceedings of the Ornithological Society of Vienna. The author is Sec. of the Aeronautical Society of Vienna). Am Eng & R R Jour-Aug. 2600 w.

*552. Pilcher's Soaring Machine. Ill. (Descriptive.) Am Eng & R R Jour-Aug. 700 w.

554. The Limit of Human Endurance of High Air Pressures (Experiment up to 76-8 lbs. pressure). Eng News-Aug. 1. 700 w.

555 The Metric Decimal System of Weights and Measures (Report of J. L. Wilkinson, International Railway Congress, with editorial comment). Eng News-Aug. 1. 3800 w.

586. Cotton Seed Oil and Its Products—A List of the Cotton Seed Oil Mills of the South. Edwin Lehman Johnson (Trade statistics, with editorial comment) Tradesman-Aug. 1. 10500 w.

*600. Insects Injurious to Stored Grain. W. G. Johnson. Am Mill-Aug. Serial. 1st part. 700 w.

†601. Glacial Notes from the Planet Mars. E. W. Claypole (Modern view of supposed glaciation). Am Geol-Aug. 3000 w.

†602. Correlations of Stages of the Ice Age in North America and Europe. Warren Upham. Ill. (Geological.) Am Geol-Aug. 5000 w.

†654. How Translatory Movement May Be Derived from Vibratory Movement. J. Woodbridge Davis (A study in molecular physics). Sch of Mines Quar-July. 3800 w.

†657. The Condensation of Fumes by Static Electricity. Malvern W. Iles (Places on record interesting facts and part of the literature relative to the use of static electricity for condensation of fog, mist, dust and smoke). Sch of Mines Quar-July. 800 w.

†683. The Analysis of Vulcanized India-Rubber. By a member of the British Society of Chemical Industry. Ind Rub Wld-Aug. 10. 3600 w.

BOOKS OF THE MONTH

An Elementary Text-Book of Hydrostatics. By William Briggs, M. A., F. C. S., F. R. A. S., general editor of the Tutorial Series; principal of University Correspondence College; and G. H. Bryant, M. A., Smith's Prizeman, fellow of St. Peter's College, Cambridge, authors of "Coordinate Geometry" and "An Elementary Text-book of Mechanics." London and New York: W. B. Clive. [208 pp., 5″×7″, cloth. Price, 50 cts.]

THIS book includes such portions of hydrostatics and pneumatics as one must know in order to pass examinations for the London matriculation. The principle is adopted of relying upon first principles, rather than memorizing mathematical formulas. The method is a good one, and the whole subject is presented in a clear, comprehensive, and effective manner. As with all of the books of this series, very numerous and well chosen practical examples are given for exercises. The principles are, therefore, thoroughly impressed upon the mind by practical work.

Motive Powers and their Practical Selection. By Reginald Bolton, past president of the Civil Mechanical Engineers' Society, associate member of the Institution of Civil Engineers, and member of the London Chamber of Commerce. New York: Longmans, Green & Co., and London, 1895. [257 pp., 5″×7½″, cloth. Price, $2.25.]

TREATS comprehensively of available motive powers for driving machinery. One of its principal merits is the very thorough manner in which it deals with the subject of oil engines, now fast coming to the front among the motors of the world. Particularly in Europe has there been recently a very great extension of the use of oil engines. In America the employment of gas engines has been more prevalent, but this will be followed soon and rapidly by the employment of oil engines, when the economy, simplicity, and convenience of these have become better known. The author is a gentleman of high attainments, well qualified to treat the subject he has undertaken to discuss. The book is printed in admirable style, with clear, bright type and well-executed diagrams illustrating the text where needed. Those desiring information upon the entire range of motors now in use will find this book a valuable help.

The Tutorial Physics. Volume IV. A Text-book of Magnetism and Electricity, with 160 illustrations and numerous examples. By R. Wallace Stewart, D. Sc., second edition, 1894, London and New York: W. B. Clive. [344 pp., 5″×7″. Price, $1.00.]

THE preface to the first edition of this book states that it was primarily written for the use of candidates for the matriculation, intermediate science, and preliminary scientific examinations of the University of London. This probably characterizes the nature of the work sufficiently to obviate the necessity of further remarks upon its original purpose and scope. The book has, however, been carefully revised, and much new matter has been added in the second edition, so that it is now brought up to date of publication. It is a thoroughly good text-book upon the subject treated. It contains some of the best problems for exercises and application of formula in electricity that we have met with.

The Mechanical Engineers' Pocket-Book. A reference book of rules, tables, data, and formulas for the use of engineers, mechanics, and students. By William Kent, A. M., M. E., consulting engineer, M. A. S. M. E., A. I. M. E. First edition. New York: John Wiley & Sons, 1895. [1087 pp., 4″×6½″. Folding morocco cover, pocket-book style, gilt edges. Price, $5.00.]

A new-comer in this well-occupied field. The author states that it is largely made up from notes acquired in his own practice as an engineer. These have also been added to by collections of engineering facts and figures, the work of many years. At the request of the publishers, a selection from this large mass of material has been made, and the result is present in this book. The general style of printing, paper, and binding are very much like that of Haswell's book, with which almost every American engineer is familiar; there appears, however, to be in this book greater symmetry of arrangement, and facts pertaining to any particular department of engineering are grouped together in a manner superior to that of some others we have seen. A very thorough index is also supplied. Of course, in the first edition of a book of this kind, errors of commission and omission are likely to have occurred, and the publishers request that those who become readers of the volume will kindly call their attention to any errors they may discover. It has been impossible to examine this large collection of data and formulæ closely in every part, but we will say that, in a general inspection of it, it has appeared to us to be a very well-prepared and reliable book.

PRACTICE AND THEORY OF THE INJECTOR. By Strickland L. Kneass, C. E., M. A. S. M. E., Franklin Institute, and Engineers' Club of Philadelphia. New York. John Wiley & Sons, 1894. [132 pp., 6″×9″, cloth. Price $1.50.]

THIS book contains an account of the early history of the Giffard Injector, and the development of the invention to its modern form; also notes upon the shape and proportion of the tubes, and the wear of the different parts, with a review of the theory, and illustrated descriptions of the most important locomotive and stationary injectors, accompanied by numerous tables and diagrams of tests. It has been the object of the author to give greater prominence to the practical side of the discussion than to the theoretical, in order to make the book useful both to those who operate injectors and those who are responsible for the motive power of large railroads. The purely mathematical theories, however, which are of such interest to students, have not been neglected. The theoretical side of the question has been considered by what the author considers the simplest method; he approaches the subject from a mechanical point of view, considering the injector as an apparatus in which the momentum of a jet of steam is transferred to a more slowly moving body of water, producing a resultant velocity sufficient to overcome the pressure of the boiler. A very cursory glance at the book is convincing that the author has undertaken to treat a subject with which he is thoroughly familiar. The style and method of treatment are good, and the printing, paper, and binding are of that high order characteristic of the books issued by its publishers.

ELECTRICAL ENGINEERS' AND STUDENTS' CHART AND Hand-Book of the Brush Arc Light System. By H. C. Reagan, Jr. New York: Norman W. Henley & Co. [48 pp., 6″×9″, cloth. Price, $1.00.]

THE purpose of this book is to supply theoretical and practical instruction with reference to the simply constructed, yet little understood, Brush dynamo; it is, therefore, adapted to the wants of students, engineers, and dynamo-tenders. The explanations and instructions are completely up to date, giving descriptions of the very latest Brush dynamo. A novel and very useful feature, which might well be imitated in other engineering works, is a detached revoluble celluloid chart. By turning this in different positions the manner of cutting the lines of force, the directions of the flow of current induced in the armature coils, the method of computing current, the flow of current to the external circuit and return to the negative brush, are all very clearly shown, as is also the position for setting the brushes. This chart is contained in a pocket made inside of the cover. Such charts might be prepared illustrating valve motions and other working parts of machines in other departments of engineering. Blank pages are left at the end of the text for memoranda. We can recommend this book without hesitation to all who desire to become familiar with the Brush system.

STREET RAILWAY INVESTMENTS. A SUPPLEMENT TO the Street Railway Journal. H. B. Hollins & Co., Bankers, corner Wall and Broad Streets, New York. [248+LXIII pp., 9½″×13″.]

THIS work is claimed to be a far more complete and satisfactory presentation of the street-railway interests of the United States than has ever before appeared. It contains the municipal statistics of the large cities and the maps of the principal systems very clearly and conveniently arranged and carefully indexed. The publisher states that accuracy has been secured by sending proof to every street-railway company for revision, in advance of publication.

BINDING SECT. JUL 2 7 1972

TA Factory and industrial
1 management
F25
v.9

Engineering

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

ENGIN STORAGE